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# Gravitational Placentography[1]

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THE RADIOLOGICAL localization of the placental site has been the subject of considerable research in recent years, and the history of methods so evolved has been presented in detail by others and need not form a part of this paper. For any given method to be acceptable, it must be simple to perform, devoid of discomfort or danger to the patient, and possessed of a high degree of accuracy. These criteria cannot be applied unreservedly to technics employing contrast media, and methods using plain films are therefore to be preferred, providing they are accurate for all practical purposes.

Procedures which show soft tissues in detail have been described many times, and crescentic shadows seen within the uterine outline on films thus obtained have been interpreted as representing the placenta. Although such shadows may well be due to placenta in most instances, it has, nevertheless, been conclusively shown that it is not possible from plain films to differentiate between placenta, amniotic fluid, and other soft-tissue densities. On films made with the patient lying down, crescentic shadows may be attributable to a falling away of the fetus from those parts of the uterine wall that are projected tangentially and filling of the resulting dead space by fluid (1). Claims concerning localization of the placenta in the absence of proof by cesarean section must therefore be accepted with considerable reserve.

Numerous methods have been employed in attempts to demonstrate the site of placental implantation. Of these, cystography has been widely used, but appears to be of value solely in vertex presentations (2), and then only when the placenta is situated anteriorly (3). In such circumstances, the diagnosis is usually readily apparent without this procedure, and it has not been employed in the present series. Amniography has been used but appears to be dangerous to both mother and fetus (4)

Demonstration of placental calcification *in utero* deserves particular mention. Blair Hartley (5) has demonstrated calcification in about 30 per cent of placentas after thirty-six weeks gestation. He emphasizes, however, the need of superb, sustained radiographic technics, which are achieved for him by one technician. In a large general hospital, such exacting criteria are almost impossible of achievement, and we have not found the method to be of great practical value, although we have not infrequently observed placental calcification.

Angiography is becoming more widely used. Our own employment of it is discussed later.

Means of differentiating between fluid

[1] From the Department of Diagnostic Radiology, University of Toronto and Toronto General Hospital. Presented at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

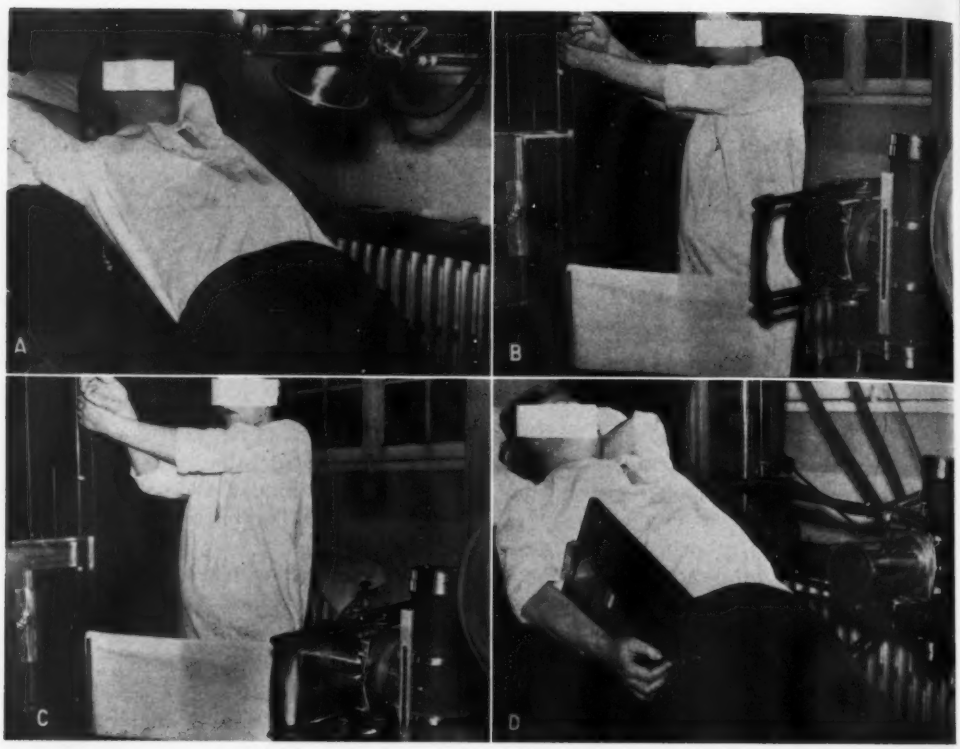


Fig. 1. Positions used (A) for anteroposterior film of abdomen; (B) for lateral film of abdomen; (C) for lateral film of pelvis; (D) for lateral film of sacral promontory and pelvic inlet.

and placenta do exist, because the specific gravity of the fetus is such that it sinks through fluid. It was this fact that led Reid (6) to his gravitational method of demonstrating placental tissue situated on the lower uterine segment. A modification of this method forms the basis of our own work, the fetus being used as a contrast medium which gravitates toward certain landmarks, in order to prove whether or not placental tissue is present on the lower uterine segment. With the knowledge of certain established facts, a limited number of standard radiographic projections may thus be employed. The established facts are as follows:

1. The crescentic shadow comprising placenta and adjacent uterine wall is approximately 25 to 30 cm. long. It is 4 to 7 cm. across and merges at each end into the shadow of the uterine wall, which is about 1.5 cm. thick. Variations within these figures occur, according to the size of the individual placenta.

2. The placenta, although it may be implanted obliquely on the uterine wall, usually extends on to the anterior or posterior wall enough to cause anterior or posterior displacement of the fetus. Lateral implantation does not prevent the diagnosis of major degrees of placenta praevia.

3. The junction of the upper and lower uterine segments during the last trimester is within the pelvic cavity just below and approximately parallel to the brim. It can therefore be represented on a lateral film of the pelvis, for practical purposes, by a line drawn from the lower border of the symphysis pubis to the first sacral segment. Before the onset of labor, the lower segment extends 7 to 11 cm. upward from the internal os (7).

4. The internal os is located in the vicinity of the ischial spines as projected on

a lateral view of the pelvis. Such a view of the pelvis, obtained before labor and with the fetal skull well engaged, frequently shows the skull to descend to this level, which it could not do were the os situated higher.

### TECHNIC

1. The bladder must be completely emptied. So essential is this that the patient is sent from the obstetric to the radiological department with a catheter in place, and this is not finally withdrawn until she is in the upright position. The importance of this can be seen from Figure 4. The films there reproduced were taken under identical conditions with the patient standing upright. Figure 4 A was made after the patient had emptied her own bladder; the fetal head is not engaged. Having seen the first films, we were not satisfied that her bladder was completely empty and she was therefore catheterized, with resultant engagement of the fetal head as shown on Figure 4 B. Attention is called to the upward displacement of the fetal skull on Figure 4 A, and also to the fact that it is away from the sacral promontory and not from the symphysis pubis, as is usually the case with displacement due to the bladder.

2. The following films are taken, at a 36-inch tube-film distance: an anteroposterior film of the abdomen with the table tilted approximately 45° from the vertical (Fig. 1 A); a lateral film of the abdomen, with a soft-tissue filter, taken with the patient standing upright (Fig. 1 B); a lateral film of the pelvis with the patient standing upright (Fig. 1 C); a lateral localized film of the sacral promontory and lower lumbar spine, which also includes the symphysis pubis, with the table tilted approximately 45° from the vertical (Fig. 1 D). For this last film a stationary grid is used.

### INTERPRETATION

Displacement of the fetus from the maternal pelvis and the uterine wall, despite the forces of gravity pulling it toward these structures, forms the basis of interpretation.

*The anteroposterior film of the abdomen* with the patient semi-erect is taken to show the presentation and lie of the fetus and the presence or absence of lateral displacement of the presenting part (Fig. 2 A). Major degrees of anterior or posterior placenta praevia can occur without lateral displacement, but, when present, such displacement is an additional diagnostic point. Rarely lateral displacement of over 2 cm. may occur in the absence of significant displacement of fetal parts from the symphysis pubis or sacral promontory as seen on the lateral films; in such circumstances, it is indicative of a laterally placed low-lying placenta. This lateral displacement may also occur without any significant crescentic shadow on the lateral uterine wall if the placenta is located obliquely. Oblique films of the abdomen might be justifiable in such circumstances, although we have not had occasion to use them and they would not appear to be desirable as a routine procedure.

The *lateral film of the abdomen* with the patient upright is taken to show the presence or absence of a placental shadow on the anterior abdominal wall (Fig. 2 B). A typical crescentic shadow must of necessity be placenta because, with the patient erect, the fetus gravitates downward and forward. It follows that a posterior crescentic shadow is not necessarily due to placenta, although, in the absence of an anterior placental shadow and with the fetal skull engaged, it probably is.

*The lateral film of the pelvis* with the patient standing upright determines the relationship of the fetal presenting part to the maternal pelvis (Fig. 2 C). Displacement of the presenting part 1.5 to 3.0 cm. from the symphysis pubis or sacral promontory is of significance but must be interpreted in relationship to other features. Thus, if the major portion of the placental shadow is seen to lie on the anterior uterine wall with its lower border in the region of the symphysis, displacement of this degree will indicate a tongue of placenta extending

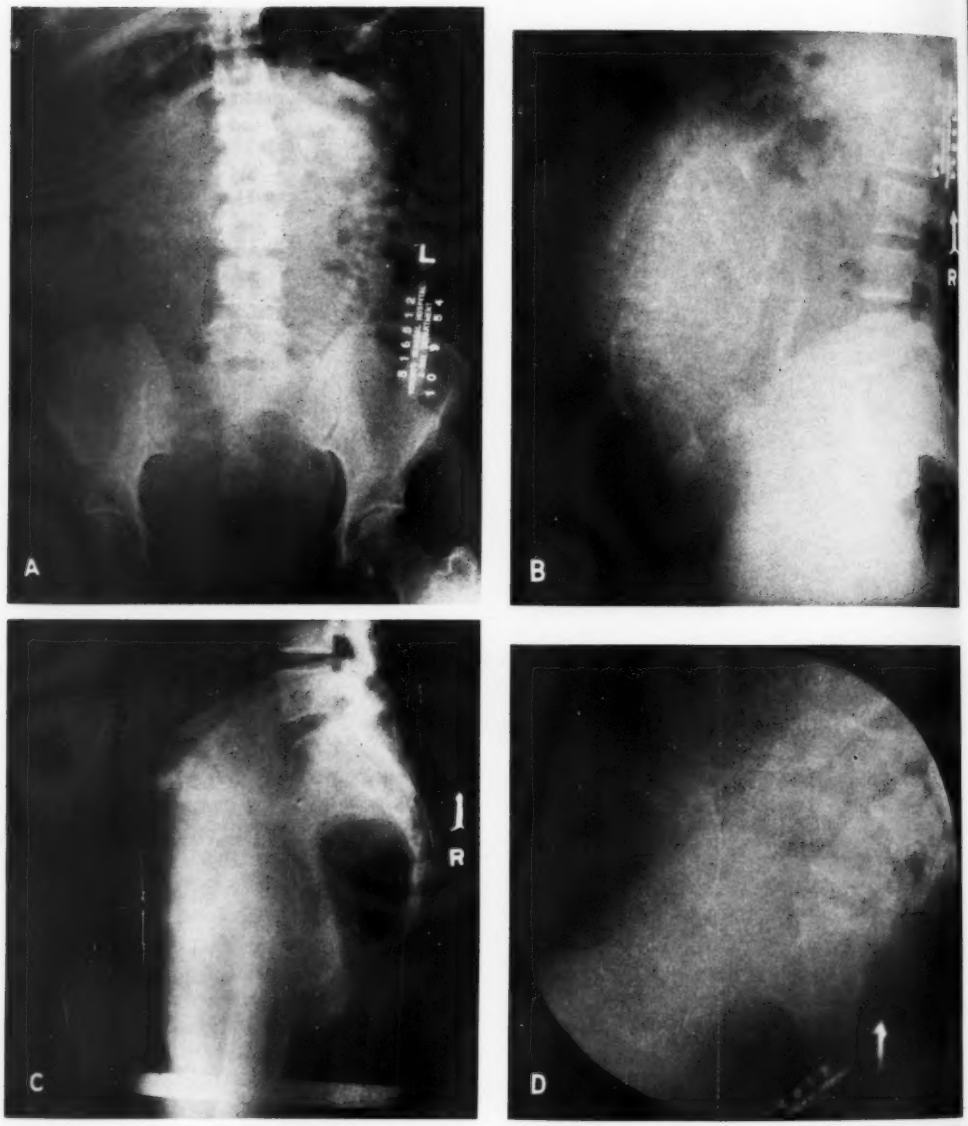


Fig. 2. Major degree of placenta praevia (posterior), proved case. A. Anteroposterior film of abdomen. High presenting part but no lateral shift.
B. Lateral film of abdomen. No evidence of a placental shadow high on the uterus or on the anterior wall.
C. Lateral film of pelvis. High presenting part which has gravitated close to the symphysis pubis but is separated by a large gap from the sacral promontory.
D. Lateral film of sacral promontory and pelvic inlet with patient semi-erect. The high presenting part and the large gap between it and the sacral promontory are unaffected by gravity.

onto the lower uterine segment, constituting a minor degree of placenta praevia (Fig. 5).

Rarely, a gap of as much as 3.0 cm. has been noted in the absence of placenta praevia but, in such circumstances, no anterior wall shadow has been demonstrated and anterior placenta praevia could thus be excluded; such appearances are usually associated with a pendulous abdomen. If,

on the other hand, the upper portion of the placental shadow is low on the anterior uterine wall and the gap between the fetus and the symphysis is 3.0 cm. or more, and the presenting part is not engaged, the appearances are those of a major degree of anterior placenta praevia. Similar degrees of displacement from the sacral promontory indicate varying degrees of posterior placenta praevia. In such cases further confirmation is required, as will be discussed below.

As an empirical but useful observation, we have noted that in no case in which the presenting part descended below the maternal mid-acetabular level on the standing lateral film of the pelvis was a major degree of placenta praevia found.

*The lateral film of the sacral promontory region* with the table tilted approximately 45° is taken in such a position that the fetus gravitates toward the lower lumbar spine and sacral promontory. Thus, any significant displacement from these parts, as demonstrated on the lateral erect film of the pelvis, may be confirmed or disproved (Fig. 2 D).

Displacements of 1.5 to 3.0 cm. have nevertheless to be interpreted with more caution than similar degrees of displacement from the symphysis pubis. We have noted displacement of up to 3.0 cm. when other features, such as an obvious anterior placental shadow, made it clear that placental tissue could not possibly be the cause. In such instances the fetus has nearly always had its back to the maternal spine and an act of extension of the skull would have been required to approximate it closely to the sacral promontory. Such equivocal displacement, therefore, becomes of significance only in the absence of an anterior placental shadow and in the presence of an occipito-anterior or transverse position. Displacement of more than 3.0 cm. nearly always indicates a major degree of placenta praevia and is always associated with a high fetal presenting part.

This lateral projection is made with a small film and cone, because excellent detail of the lumbosacral and symphyseal regions is essential and is difficult to attain with a large film, with a stationary grid. If we could obtain as detailed an image using a large film, we would do so, as a more satisfactory picture of the posterior uterine wall could be obtained. Although included as a "routine view," this film is necessary only when the other views show a high presenting part and a large gap between the fetus and the sacral promontory or symphysis pubis. It is, nevertheless, extremely important and in many cases is the key film in the diagnosis of placenta praevia.

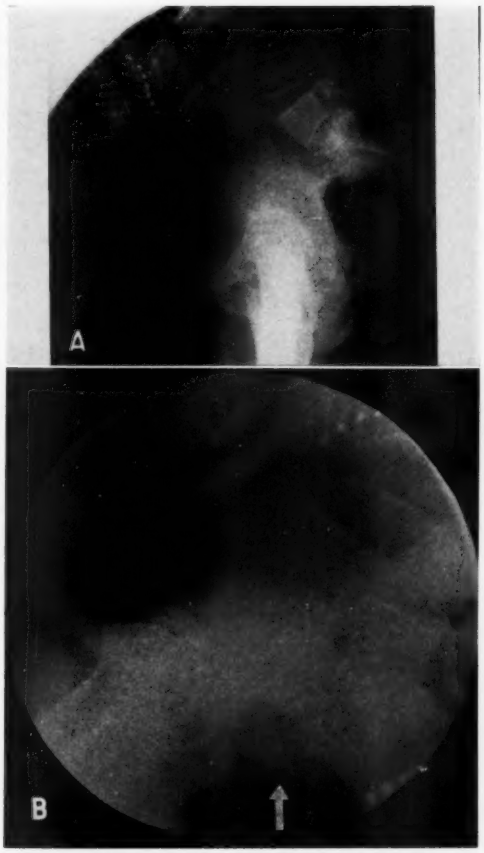


Fig. 3. Proved major degree of placenta praevia (central) associated with a breech presentation.
A. Lateral film of pelvis with the patient upright. Large gap between presenting part and pelvic inlet.
B. Lateral localized film of inlet with patient semi-erect. The displacement of the fetus is not affected by gravity.

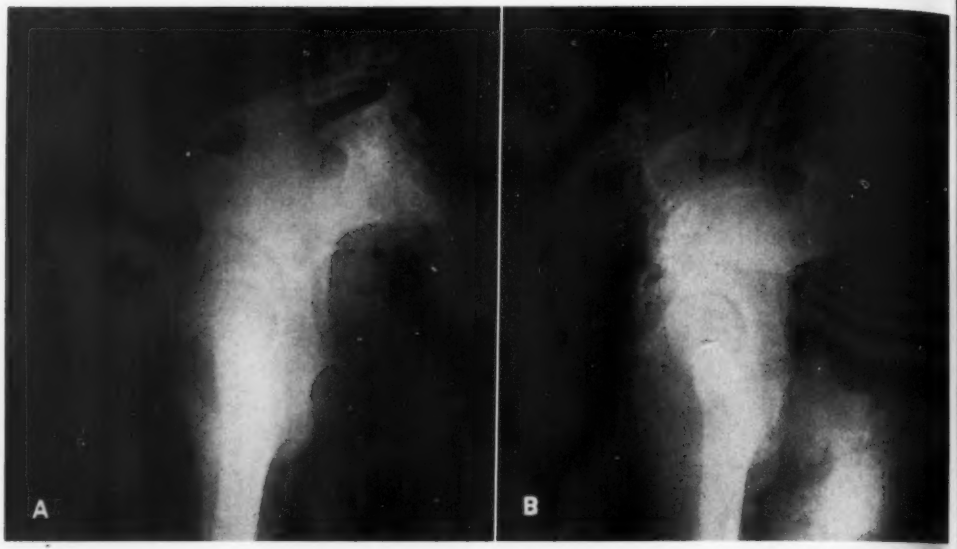


Fig. 4. Lateral erect views of pelvis to show effect of an incompletely emptied bladder.
A. High fetal head unaffected by gravity, as seen before catheterization.
B. After catheterization. The fetal head has descended into the pelvic cavity.

### DIFFERENTIAL DIAGNOSIS

*Pelvic Tumors:* Pelvic tumors not containing calcium may be quite indistinguishable from a major degree of placenta praevia. We ourselves have not encountered any such case.

*Bladder and Bowel:* As previously noted, a full bladder may cause appearances indistinguishable from a major degree of placenta praevia, and for this reason, the bladder should always be catheterized. Very large amounts of fecal material in the pelvic colon may also be responsible for appearances simulating a major degree of placenta praevia, although we have not experienced any error that could be attributed to this cause.

### ANALYSIS OF MATERIAL

Before stating results, it is necessary to define terms regarding placenta praevia.

The diameter of the placental shadow varies between 25 and 30 cm. From our films we cannot be certain exactly where the lower border of the placenta is situated when it is on the lower uterine segment, and we therefore cannot localize it more accurately than within 5 cm. even though we can see its upper border. This means that a large placenta may completely cover the os, and will therefore be a central placenta praevia, whereas a smaller placenta will not quite reach the os or only partially cover it; yet, radiologically, we cannot tell the difference. Likewise, when the margin of the placenta is in the region of the junction of the upper and lower uterine segments, we cannot be sure whether it is at the junction of the segments or extends on to the lower segment for a further 5 cm. and is thus about halfway to the internal os.

For radiological purposes, therefore, we can refer either to major degrees of placenta praevia, in which the placenta completely covers the internal os or has its edge in close proximity to it; or to minor degrees of placenta praevia, in which the edge of the placenta extends on to the lower uterine segment, but is less than halfway to the internal os.

Our experience leads us to believe that claims to diagnose degrees of placenta praevia beyond these limits of accuracy on the basis of plain radiographs are unfounded. The question remains whether

such limits are adequate for all practical requirements. In our hospital, the answer would appear to be in the affirmative, as judged by the continuing requests for radiological examination of patients in whom the occurrence of placenta praevia is suspected.

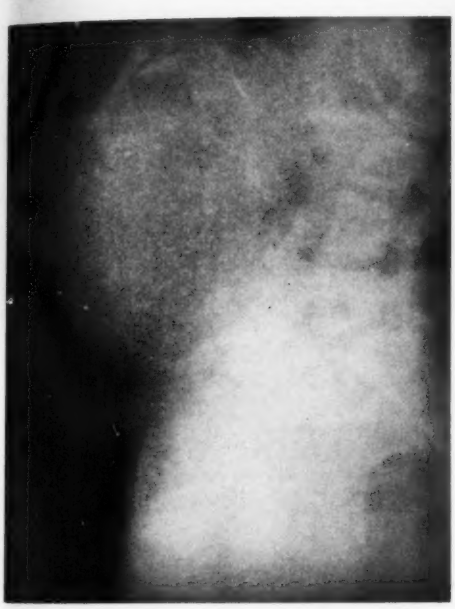

Fig. 5A. Proved minor degree of placenta praevia (anterior). The long thin placental shadow on the anterior uterine wall is in such a position that the lower margin could be extending on to the lower uterine segment.

In a recent study of all proved cases of placenta praevia encountered at Bellevue Hospital, New York, between the years 1919 and 1954, Reich (8) has limited the designation placenta praevia to those cases in which the placenta is implanted in the region of the dilating zone of the cervical internal os and produces an obstructing organ interfering with the descent of the fetus. He emphasizes that the inclusion in the placenta praevia group of so-called "low implantation," in which the placenta does not reach the area of the anatomical internal os, has been studiously avoided. The need for differentiation of this group from true placenta praevia is imperative, as the management of "low implantation," in

Fig. 5B. Same case as in Fig. 5A. There is a gap of 3 cm. between the fetal presenting part and the symphysis pubis, unaffected by gravity.

contrast to placenta praevia, should be conservative.

It would thus appear that one could, for practical purposes, simplify one's diagnoses still further by confining them to "placenta praevia" and "no placenta praevia." The great majority of our patients with "minor degrees" of placenta praevia, corresponding to Reich's group of "premature separation of low implanted placenta," deliver normally, often without conclusive clinical proof of low implantation.

We feel, nevertheless, that the radiologic diagnosis of minor degrees of placenta praevia should continue to be made. Final clinical proof will often be lacking, but the diagnosis may be of great value. In one of our cases (Fig. 5) diagnosed as a minor degree of anterior placenta praevia, the patient continued to bleed profusely. A cesarean section was performed and the radiological diagnosis was confirmed. A large ruptured marginal sinus was found at the point at which the placenta was encroaching upon the lower uterine segment. In two other cases diagnosed as minor degrees of placenta praevia, the placenta was of the broad, thin type and extended to the

region of the internal os, constituting a major degree.

This study is based upon 200 consecutive cases in which there was clinically good reason to suspect placenta praevia. Of these, 180 were referred for radiological examination because of severe bleeding or spotting, and 20 for other reasons, mostly a high or unstable presenting part. The findings were as follows:

| | |
|---|---|
| *Radiological Positive Diagnosis of a Major Degree of Praevia* | |
| Total | 36 |
| Confirmed clinically | 34 |
| Excluded clinically | 2 |
| *Radiological Exclusion of Placenta Praevia* | |
| Total radiologically negative for placenta praevia | 145 |
| Confirmed clinically negative for placenta praevia | 139 |
| Clinically found to be a major degree of placenta praevia | 3 |
| Clinically found to be a minor degree of placenta praevia | 3 |
| *Radiological Diagnosis of Minor Degrees of Placenta Praevia* | |
| Total diagnosed radiologically | 19 |
| Confirmed clinically | 7 |
| Excluded clinically | 0 |
| Clinically not certain | 10 |
| Clinically found to be a major degree of placenta praevia | 2 |

The diagnostic criteria outlined in the previous paragraphs apply to abnormal as well as to vertex presentations.

No errors in diagnosis or exclusion have been made in any of the breech presentations encountered. A major degree of placenta praevia was diagnosed in 4 cases of breech presentation and confirmed by cesarean section in all of them. In interpreting films of breech presentation, it is important to remember that the fetal pelvic bones are covered by much thicker soft tissues than the skull, and it is the distance between the soft tissues and the maternal pelvis that is of importance. Even if the subcutaneous fat of the fetal buttocks cannot be outlined, it is always possible to estimate, with a fair degree of accuracy, the limits of the soft tissues (Fig. 3, A and B).

Rather surprisingly, transverse lies have not resulted in any errors of diagnosis or exclusion. In 5 such cases a major degree of placenta praevia was diagnosed and confirmed by cesarean section. The answer appears to lie in a careful analysis of the type of transverse lie. In the cases with associated major placenta praevia, the back

Fig. 6A. Proved major degree of placenta praevia (central) diagnosed by angiography at twenty-eight weeks. Arterial phase, showing large tortuous branches of both uterine arteries supplying the placenta.

of the fetus was arched markedly upward in 4, and slightly downward and forward in 1, but never markedly downward. In each case, also, the limbs remained well out of the pelvis, with the patient standing upright, and no placental shadow could be seen elsewhere on the uterus. Very rarely an idiopathic transverse lie will give identical appearances, but we have encountered only 2 such instances in our obstetrical examinations in the past four years, both in the course of pelvimetry. Because of these 2 cases, and because it is logical to assume that a major degree of placenta praevia could occur with a transverse lie in the absence of the radiological signs described, the diagnosis or exclusion of placenta praevia associated with this position

would appear to be less certain than with breech or vertex presentations.

Of the 2 cases diagnosed as placenta praevia of major degree but excluded as such clinically, one was an unstable presentation in which the fetus was held as a vertex presentation by the obstetrician

Fig. 6B. Same case as in Fig. 6A. Sinus phase of angiography. The placenta is clearly demonstrated by contrast medium within the sinuses.

during the taking of the films. As already implied, we have abandoned such procedures as confusing; at the present time we would pay more careful attention to the details of the abnormal presentation and would also obtain a retrograde femoral arteriogram if doubt still existed. The other error was made by attempting to interpret films of a quality which we would certainly not accept today. Although we cannot expect technicians to superimpose the acetabula precisely on every lateral film of the pelvis, they should come very close to it; otherwise lateral films are not acceptable.

In the 3 cases with a negative diagnosis, but in which a major degree of placenta praevia was found clinically, the same comments regarding technic apply. One case was particularly interesting, as well as disappointing: A major degree of placenta praevia was diagnosed at thirty weeks but a repeat examination at thirty-four weeks, requested because of doubt, showed only marked lateral displacement of the presenting part without the displacement from the sacral promontory previously demonstrated. The earlier diagnosis was therefore reversed. On a review of the films, the lateral views of the final examination were considered to be inadequate. Even so, the previous positive findings, together with persistent marked lateral displacement, should have led to a confirmation of the diagnosis rather than to a reversal of opinion.

Three cases of minor degree of placenta praevia in which the condition had been excluded radiologically, were diagnosed clinically after delivery. These errors, however, are principally of academic interest, as the treatment of a patient who is bleeding, in whom a major degree of placenta praevia has been excluded, is conservative yet careful, whether or not a minor degree of placenta praevia has been diagnosed. Also it is often difficult clinically to be sure by post-partum palpation whether a thin tongue of placenta did in fact extend onto the lower uterine segment

The period of gestation at which the patient is examined is of importance, but no hard and fast rule can be adopted. Of our patients, 18 were examined before the thirty-second week and the proportion of errors was no greater than in those examined later. I believe, nevertheless, that in our next 200 patients we shall have fewer errors after the thirty-second week. In our present series we have probably been a little lucky in those seen before the thirty-second week, and our errors may become greater in this group. As a working rule, therefore, if the fetus is obviously small in relation to the pelvis and the gestation period is less than thirty weeks, diagnosis by the gravitational method should be made with considerable reserve.

Because of the uncertainties of diagnosis with a small fetus and, occasionally, with

an abnormal presentation, we have employed percutaneous retrograde femoral arteriography in such cases during the past two years. The accuracy of the gravitational method has been such that the opportunities to use angiography have been relatively few, but it has produced very satisfactory results. Our method is a modification of that described by Sutton (9) and a simplification of that described by Fernström (10). A specially made arterial cannula is inserted percutaneously into one or other femoral artery and threaded a short distance into the common iliac artery. Blood pressure cuffs are inflated above both knees, and 30 c.c. of 50 per cent Diodrast is injected rapidly. The Diodrast passes directly into the iliac arteries on the side of injection and across the aortic bifurcation into the iliac arteries on the opposite side. Both uterine arteries fill, and the placental blood supply is clearly seen on films taken immediately after injection, followed by other films at two and four seconds. We have demonstrated five major degrees of placenta praevia by this method. A typical case is shown in Fig. 6.

## CONCLUSION

A high degree of accuracy may be obtained by the gravitational method of placentography, and the method has the great merit of being technically simple because it relies entirely on plain radiographs; it is also virtually devoid of discomfort or danger to the patient.

In both diagnosis and exclusion of placenta praevia, we have achieved an accuracy of 95 per cent and feel that this can still be improved. The proportion of clinically proved cases of major degrees of placenta praevia in this series is high, 39 out of 200 cases. The explanation for this lies almost certainly in the fact that all of our patients were strongly suspected clinically of having placenta praevia. This report, therefore, represents a study in practical problems rather than an academic one conducted on patients with uncomplicated pregnancies.

Neither breech presentations nor transverse lies have resulted in errors. It is not anticipated that breech presentations will lead to difficulties in the future but transverse lies may do so. Manual version of the fetus in these cases may lead to confusing radiographs and to errors in interpretation and for this reason is not advocated.

Diagnosis is more uncertain when the fetus is small and before thirty weeks gestation. In these cases and in those cases of transverse lie in which doubt is still present after the gravitational method has been employed, we have adopted retrograde femoral arteriography as a diagnostic procedure, with excellent results. The number of cases in which arteriography is called for is, nevertheless, extremely small.

The routine projections used in gravitational placentography are not of value in demonstrating the placental site when it is above the lower uterine segment, unless it is directly on the anterior or posterior uterine wall. The so-called "soft tissue technics" often show crescentic shadows but these may occasionally be due to amniotic fluid filling in the dead space between the fetus and the uterine wall. The anteroposterior and lateral films of the abdomen in our gravitational method are, in fact, made with particular regard to soft-tissue detail; nevertheless, the only crescentic shadows that can be definitely regarded as due to placenta are those which persist despite the forces of gravity unsuccessfully trying to pull the fetus through them.

Once the placental site has been excluded as being on the lower uterine segment, the actual site on the upper segment becomes of little practical importance.

With gravitational placentography as the main diagnostic procedure, and retrograde femoral arteriography as an infrequent ancillary technic, it would appear that the radiological diagnosis or exclusion of placenta praevia can be accomplished in nearly every case.

## SUMMARY

A modification of Reid's method of em-

ploying the effects of gravity upon the fetus to determine whether or not placenta praevia is present is described.

Two hundred patients suspected of having placenta praevia were examined. In 36 of these a major degree of placenta praevia was diagnosed radiologically, and in 34 this diagnosis was confirmed clinically. An equal degree of accuracy (95 per cent) was achieved in the exclusion of placenta praevia.

The use of retrograde femoral arteriography as an ancillary method in those few cases in which gravitational placentography gives doubtful results is described.

ACKNOWLEDGMENTS: Appreciation is expressed to Professors D. E. Cannell and A. C. Singleton, and to all the other obstetricians and radiologists at the Toronto General Hospital, for their help and encouragement in carrying out this work. I should like, also, to thank Mr. T. B. Hurst, Mr. C. Robb, and the other members of the x-ray technical and secretarial staff for their invaluable assistance.

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## SUMMARIO IN INTERLINGUA

### Placentographia Gravitational

Es describite un technica gravitational pro le demonstration de placenta previe. In illo le feto servi como medio de contrasto. Le objectivo es indicar si o non tessuto placental es presente al segmento infero-uterin. Quatro expositiones es obtenite: (1) Abdominal anteroposterior, con le tabula basculate a circa 45 grados ab le vertical; (2) abdominal lateral, con le patiente erecte; (3) pelvic lateral, con le patiente erecte; e (4) vista localisate lateral del promontorio sacral e del columna vertebral infero-lumbar, incluse le symphyse pubic, con le tabula basculate a 45 grados. Le displaciamento del feto ab le pelve e le pariete uterin del matre in despecto del fortia de gravitate que tira lo verso iste structuras representa le base de interpretation.

Duo centos casos con suspicion clinic de placenta previe esseva examinate per iste technica, con un accuratia general amontante a circa 95 pro cento. In 36 casos, major grados de placenta previe esseva diagnosticate, con confirmation clinic in 34. In 145 casos, placenta previe esseva eliminate super le base del studio radiologic, con confirmation clinic de iste elimination in 139. Grados minor de placenta previe esseva diagnosticate in 19 casos. In 7, le diagnose radiologic esseva confirmate clinicamente; in 2, major grados de placenta previe esseva trovate clinicamente; in 10, le diagnose clinic esseva indecise.

Ni presentation per le nates ni position transverse del feto resultava in errores del diagnose.

# The Significance of the Calcified Appendiceal Enterolith[1]

BOYER M. BRADY, M.D., and DAVID S. CARROLL, M.D.

ENTEROLITHS of the appendix originate as inspissated concretions of fecal material. If the size of the fecalith or the motility of the appendix is such that the fecalith remains in position for an extended period of time, calcium may be deposited on its surface. Stasis, particularly with bacterial infection, increases the likelihood of calcium deposition. The first radiological demonstration of a calcified appendiceal enterolith was reported by Weisflog in 1906. Since that time, approximately 155 cases have been recorded in the world literature.

Acute appendicitis is the most common abdominal disease requiring surgical intervention; it is the cause of 17,000 deaths per year in the United States alone. Any factor, therefore, which will aid in the early diagnosis and management of appendicitis is of considerable importance. During the past five years, in the John Gaston Hospital, of Memphis, calcified appendiceal enteroliths were demonstrated by x-ray examination in 34 patients. The reason for presenting this series of cases is to show (*a*) that demonstration of the calcified appendiceal enterolith may be of considerable help in the differential diagnosis of the acute surgical abdomen, and (*b*) that the incidence of perforation is greatly increased by the presence of a calcified enterolith.

## CASE REPORTS

CASE I: An 8-year-old colored girl was admitted to the hospital with a history of abdominal pain and diarrhea of two days duration. She was quite dehydrated and her temperature was 102°. The abdomen was somewhat distended and tympanitic, with diffuse tenderness and generalized muscle guarding. There was a leukocytosis of 20,450. Because of severe diarrhea and lack of localized findings, the clinical diagnosis was acute gastroenteritis.

Fig. 1. Large calcified appendiceal enterolith overlying the lower end of the sacroiliac joint.

X-ray examination of the abdomen (Fig. 1) revealed an oval calculus, 1.6 cm. in its greatest dimension, overlying the lower part of the sacroiliac joint on the right. Calcification was limited to the periphery of the stone. Considerable gas was observed in the colon and in several loops of small intestine. In addition, there was radiological evidence of a moderate amount of free peritoneal fluid and the properitoneal fat line was partially obscured on the right side. A diagnosis of acute appendicitis with calcified appendiceal enterolith was made. Laparotomy revealed a gangrenous appendix with perforation. The calculus had been extruded through the perforation and was free in the abdominal cavity. Recovery was uneventful, the patient being discharged six days after admission.

CASE II: A 13-year-old colored male was admitted to the hospital complaining of pain in the left side of the abdomen at the level of the umbilicus; a rather ill-defined mass was palpated in that area. The white blood count was 14,750.

[1] From the Departments of Radiology of the University of Tennessee and the City of Memphis Hospitals, Memphis, Tenn. Presented at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

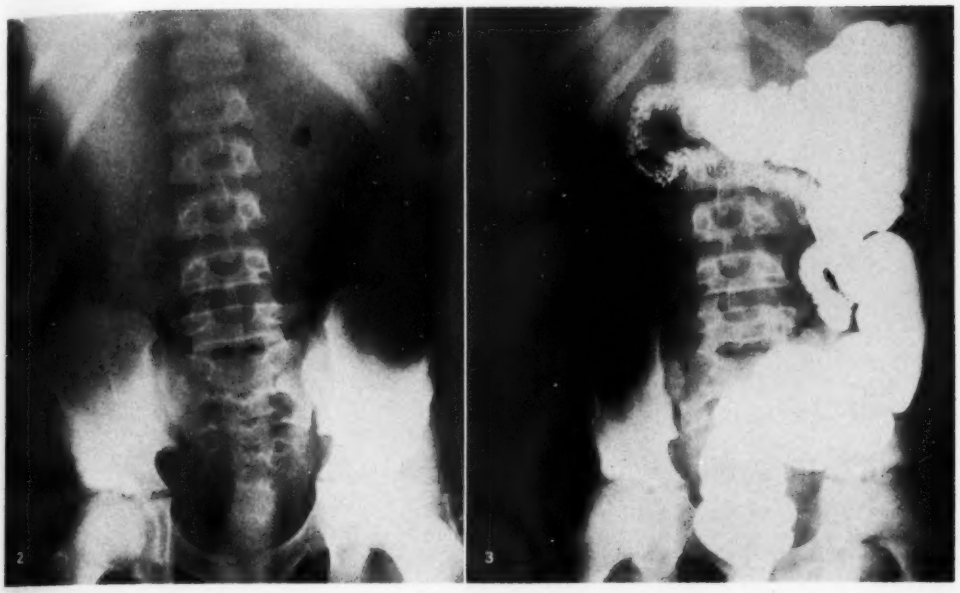

Fig. 2. Calcified appendiceal enterolith in left mid-abdomen.
Fig. 3. Same patient as Figure 2. A barium enema study demonstrating nonrotation of the colon explains the unusual position of the appendiceal enterolith in the left side of the abdomen.

X-ray examination of the abdomen (Fig. 2) disclosed an oval, laminated calcific density 2.1 cm. in the greatest dimension, located in the lateral portion of the abdomen on the left side, at the level of the transverse process of the third lumbar vertebra. The stone was situated too far laterally to suggest renal calculus. A barium enema revealed non-rotation of the colon with the cecum lying in the left mid-abdomen (Fig. 3). The calculus was shown to lie quite close to the cecum. A diagnosis of acute appendicitis with perforation and periappendiceal abscess was made and the patient was treated conservatively. An internal appendectomy, three months later, revealed a periappendiceal abscess containing the large calculus. The postoperative course was uneventful.

CASE III: A 51-year-old white man was admitted to the hospital because he "thought his appendix had ruptured." Pain in the right upper abdomen, radiating to the right shoulder and arm, had persisted for three days prior to admission. Nausea, vomiting, chills, and fever were associated symptoms. The white blood count was 24,500 and the temperature 101°. Tenderness and rigidity were localized to the right upper quadrant, but no mass was felt. A clinical diagnosis of acute cholecystitis was made.

X-ray examination of the abdomen revealed four calcified stones high in the right upper quadrant (Fig. 4). The stones were faceted and varied from 3 to 6 mm. in diameter. They were in a somewhat higher position than is usual for gallstones. The distribution of the stones was linear, but the stones in the lateral position were somewhat higher than those located medially, which is the reverse of the usual arrangement of gallstones. In addition, there was a mild elevation of the right leaf of the

Fig. 4. Four calcified enteroliths in the lateral portion of the abdomen high under the liver.

Fig. 5. Distention of the colon with fecal material due to congenital megacolon. Two calcified appendiceal enteroliths in the right lower quadrant are superimposed one over the other.

Fig. 6. Same patient as Figure 5, after perforation of the appendix with extrusion of the enteroliths, the stones are now demonstrated just above the sacrum and just to the right of the mid-line.

diaphragm. In spite of the somewhat unusual distribution of the calculi, they were thought to represent gallstones. At surgery, however, a gangrenous, perforated retrocecal appendix with periappendiceal abscess was found, high under the liver. The postoperative course was uneventful. Although the correct diagnosis was not made preoperatively, appendicitis with perforation probably should have been considered because of the distribution and location of the stones. The fact that the patient was the only one who made the correct diagnosis was most disconcerting.

A fourth case, to be discussed in some detail, is presented because it indicates why prophylactic appendectomy should be considered if a calcified appendiceal enterolith is demonstrated in the absence of symptoms referable to the appendix.

CASE IV: A five-year-old white boy was admitted to the hospital with a history of severe constipation since birth. The history and physical findings were those of congenital megacolon. X-ray examination of the abdomen (Fig. 5) revealed marked distention of the colon with fecal material. Two partially superimposed calcific densities were observed overlying the wing of the right ilium. Calcification was rather diffusely distributed in both of the faceted calculi, which measured 3 and 8 mm. in diameter. A barium enema study revealed the typical changes of megacolon, with the narrow segment in the region of the rectosigmoid junction. The radiologic diagnosis was calcified appendiceal enterolith and congenital megacolon. An abdominoperineal "pull-through" surgical procedure was performed, and the immediate postoperative course was uneventful.

On the seventh postoperative day, there was a sudden onset of severe abdominal pain, with nausea, vomiting, and fever. X-ray examination of the abdomen (Fig. 6) showed the two stones to have changed position so that they were now just medial to the sacroiliac joint. An emergency appendectomy was performed, and the appendix was found to be gangrenous and perforated, the two enteroliths having been extruded through the perforation into the peritoneal cavity.

## COMMENT

Of the 34 patients with calcified appendiceal enteroliths seen in the John Gaston Hospital, 25 were males. The youngest patient was three years of age and the oldest sixty-five, the average being twenty years. Seventeen were in the pediatric

age group. In most of the patients the symptoms and physical findings were such that acute appendicitis was the obvious preoperative diagnosis. In a few, however, the symptoms and signs were more difficult to interpret, and the radiologic demonstration of a calcified enterolith contributed significantly to the differential diagnosis.

Fig. 7. A very densely calcified laminated enterolith overlying the wing of the ileum.

In 4 patients, calcified appendiceal enteroliths were demonstrated in the absence of any symptoms or signs of acute appendicitis. One of these was the child with congenital megacolon already discussed (Case IV). Another was a patient who had an x-ray examination of the pelvis (Fig. 7) demonstrating the calcified appendiceal enterolith several weeks before admission to the hospital for acute gangrenous appendicitis with perforation. In a third patient a cholecystogram had demonstrated the appendiceal enterolith two years before admission for acute appendicitis with perforation. This enterolith was not seen by the radiologist at cholecystography and it was not discovered until

Fig. 8. Four calcified appendiceal enteroliths in a typical appendiceal position.

the films were reviewed at the time of admission for acute appendicitis. The fourth patient had undergone gastrointestinal study and cholecystography for rather vague abdominal complaints. Four faceted, calcified enteroliths were demonstrated in the appendix (Fig. 8), and a prophylactic appendectomy was performed. The appendix showed no evidence of acute inflammation, and the patient continued to experience vague abdominal symptoms.

It is important to note that not a single patient gave a history compatible with previous attacks of acute appendicitis. Thirty-two of the series of 34 had perforation of the appendix, the only exceptions being the case in which prophylactic appendectomy was performed and the one with gangrenous appendicitis without perforation. Of the cases previously reported in the literature, 90 per cent were associated with acute appendicitis, but in only 50 per cent was there perforation of the appendix. The remarkably high

incidence of perforation in our series may be explained by the fact that the average time lapse between onset of symptoms and medical consultation was three and a half days. Several patients had taken laxatives, which undoubtedly contributed further to the incidence of perforation. Calcified appendiceal enteroliths are associated with appendiceal stasis, however, and in the presence of acute inflammation, this leads to early rupture.

Solitary enteroliths were found in 24 of the 34 cases. Six of the remaining patients had 2 each, 2 had three, and 2 had four. The stones varied from 0.3 to 2.1 cm. in diameter, the average size being 1.0 cm. The vast majority are oval in shape, but multiple stones may be faceted. In 8 cases, calcium was rather diffusely distributed throughout the stones, but in the remaining 26 it was limited to the periphery or laminated in two or more layers. Most of the enteroliths were located in the right lower quadrant, but exceptions were encountered when the appendix was retrocecal in position or when there was an associated malrotation of the colon. In 2 instances, the location was noted to change after perforation.

The differential diagnosis is usually not difficult. The most important single entity to be differentiated is a right ureteral calculus. The appendiceal enterolith is usually larger and the calcium distribution is commonly peripheral, whereas in a urinary calculus calcification is usually diffuse. As a rule, the long axis of a ureteral calculus is parallel to the course of the ureter while in an appendiceal calculus the long axis is often at right angles to the ureter. Also to be included in the differential diagnosis are calcified lymph nodes, phleboliths, bone islands in the ilium, gallstones, calcified arteries seen on end, calcification in a cyst, such foreign bodies as opaque medication, film artifacts, and papillomas of the skin. At times diagnostic adjuncts such as stereoscopic views, urological investigation, and repeat roentgenograms after an interval of a few hours are of help in localizing the calcific density. Much information can be obtained from a barium enema study, but in view of possible acute appendicitis, the advisability of this procedure is questionable. The barium enema is very helpful, however, in cases where there are no associated abdominal symptoms.

## CONCLUSIONS

1. The demonstration of a calcified appendiceal enterolith is helpful in the differential diagnosis of the acute abdomen.
2. The incidence of perforation is greatly increased by the presence of a calcified appendiceal enterolith.
3. The lapse of time between onset of symptoms and perforation is reduced in the presence of a calcified appendiceal enterolith.
4. A prophylactic appendectomy is indicated in most cases where a calcified appendiceal enterolith is demonstrated, in the absence of abdominal symptoms.

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SUMMARIO IN INTERLINGUA

**Le Signification del Calcificate Enterolitho Appendicular**

Intra un periodo de cinque annos, 34 casos de calcificate enterolitho appendicular esseva incontrate in un sol hospital. In 4 patientes le calculos esseva demonstrate in roentgenogrammas in le absentia de symptomas.

Trenta-duo del patientes habeva perforationes del appendice. Le importantia de calcificate enterolithos como factores contributori al occurrentia precoce de iste evento critic as sublineate. A causa del periculo potential, appendicectomia prophylactic es indicate in casos in que un calcificate enterolitho ha essite demonstrate, mesmo in le absentia de symptomas abdominal.

Quatro reportos de casos illustrative es includite.

# Roentgenographic Findings in Familial Dysautonomia[1]

ROB H. KIRKPATRICK, M.D., and CANRAD M. RILEY, M.D.

FAMILIAL DYSAUTONOMIA is a clinical entity characterized by dysfunction of the nervous system with particular prominence of autonomic disturbances. Excessive perspiration, drooling, transient erythematous blotching of the skin, intermittent hypertension and postural hypotension, inability to produce tears, and inadequate temperature control are expressions of the abnormal autonomic function. Dysfunction in the remainder of the central nervous system is indicated by such symptoms and signs as relative indifference to pain, hyporeflexia, poor motor coordination, and retarded motor development. Other features frequently observed include emotional instability, cyclic vomiting, pulmonary infections, fever of undetermined origin, difficulty in feeding and swallowing, and breathholding spells in infancy. Mental retardation and convulsions are occasionally present. All of these manifestations occur for the most part during infancy and early childhood. Of 80 known patients with dysautonomia, all were of Jewish extraction, with 2 convincing exceptions, of which 1 was reported by Linde (3). The familial pattern suggests transmission by a simple recessive gene. Further clinical information may be obtained from articles by Riley and his associates (5–7).

Familial dysautonomia is a serious condition which can disable the patient and disrupt the family. Its early recognition greatly aids the parents in understanding the situation and planning for the care of the child. The diagnosis is made from the clinical findings listed above. There are no significant laboratory findings.

TABLE I: EXPERIENCE WITH 34 CASES OF FAMILIAL DYSAUTONOMIA STUDIED ROENTGENOGRAPHICALLY

| Part Examined or Examination | Number of Cases | Normal | Borderline | Abnormal | Diagnosis or Findings |
|---|---|---|---|---|---|
| Lungs | 32 | 9 | 4 | 19 | Bronchopneumonia |
| Bronchogram | 4 | 4 | — | — | |
| Heart | 32 | 30 | — | 2 | Congenital heart disease |
| Skeletal maturation | 16 | 9 | — | 7 | Delayed maturation |
| Thoracolumbar spine | 18 | 11 | — | 7 | Scoliosis in 6<br>Kyphosis in 1 |
| Skull | 20 | 18 | 1 | 1 | Enlarged |
| Hips | 12 | 10 | — | 2 | Congenital dislocation in 1<br>Ischemic necrosis in 1 |
| Lower extremities | 4 | 1 | — | 3 | Fractures |
| Feet | 5 | 3 | — | 2 | Pes cavus in 1<br>Ischemic necrosis of the tarsonavicular in 1 |
| Upper gastrointestinal series | 7 | 6 | — | 1 | Pylorospasm |
| Intravenous pyelogram | 3 | 3 | — | — | |
| Presacral aerogram | 1 | 1 | — | — | |
| Pneumoencephalogram | 3 | 3 | — | — | |
| Myelogram | 1 | 1 | — | — | |

The radiological literature contains nothing regarding the roentgen aspects of familial dysautonomia, although Caffey (1) has discussed the pulmonary findings in his textbook. This paper is presented to acquaint radiologists with this disease and to relate the authors' experience with 34 patients with dysautonomia examined in the Radiology Department of Babies Hospital, New York.

## MATERIALS AND METHODS

The roentgen findings in the 34 cases are summarized in Table I. Under the

[1] From the Departments of Radiology and Pediatrics, College of Physicians and Surgeons, Columbia University, and Babies Hospital, New York. Accepted for publication in November 1956.

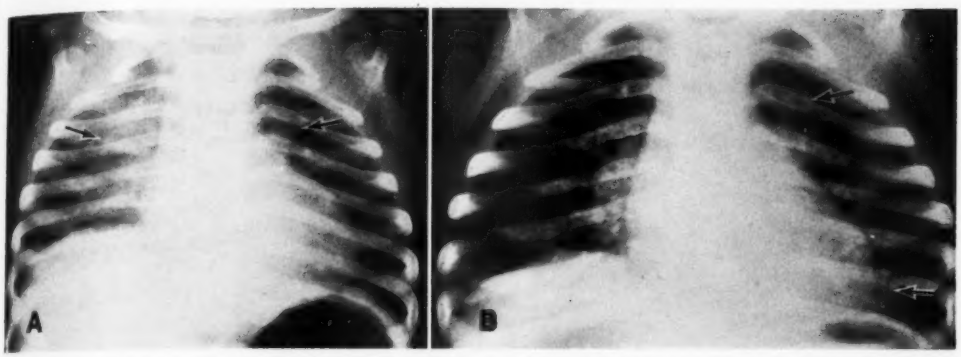


Fig. 1. Usual findings in dysautonomia. A. Initial roentgenogram showing bilateral perihilar increased densities with extension of the process into the upper part of both lungs. The child had a slight cough but no fever.

B. Further extension of the patchy densities in the left lung after a three-year interval. No evidence of emphysema. The patient is asymptomatic.

heading "number of cases" is given the number of patients who received at least one roentgenographic examination of the part examined. The heading "abnormal" indicates the number of cases shown to be abnormal in at least one roentgenogram, although the patient may have undergone repeated roentgen studies, of which some were normal. The nature of the abnormal findings is given in the final column.

Since most roentgenograms were taken because of clinical indications, the results in general indicate the incidence of positive roentgen findings in symptomatic dysautonomic children rather than in dysautonomia as a total group. Twelve patients, however, without a history of respiratory abnormalities, received roentgenographic examinations of the chest.

## ROENTGEN FINDINGS

*The Respiratory System:* Bronchopneumonia is the most common and most important roentgen diagnosis in familial dysautonomia. Of 32 patients who had roentgenograms of the chest, 19 (about 60 per cent) showed evidence of bronchopneumonia. This was generally of a chronic nature. In 9 cases follow-up roentgenograms obtained over periods of one to thirty-two months showed no clearing even though the patients became asymptomatic after antibiotic therapy. In 3 patients there was complete clearing of the pneumonic process, and the remaining 7 had no follow-up studies.

Four patients, each with a single examination, displayed questionable linear interstitial infiltration suggestive of pneumonia. The lack of further roentgen examinations on these patients makes it impossible to classify them. They are entered as borderline in Table I.

As previously mentioned, 12 patients with roentgenograms of the chest had no present or past history of respiratory abnormalities. Five of these had normal roentgenograms, 3 had borderline findings, and 4 had bronchopneumonia, roentgenographically.

There are no roentgen findings differentiating the bronchopneumonia seen in dysautonomia from aspiration bronchopneumonia. The most common picture is one of patchy increased densities in one or both perihilar regions, with extension of the process into one or two lobes. This occurred in 13 of the 19 cases of bronchopneumonia (Fig. 1). Of the remaining 6 patients, 1 had diffuse bilateral involvement; in 5 one or two lobes showed either patchy or homogeneous changes. In 11 of the 19 cases the upper part of the right lung was affected, but pneumonia was always present in some other part of the lung as well.

Moloshok and Moseley (4) have stressed three abnormal roentgen findings observed

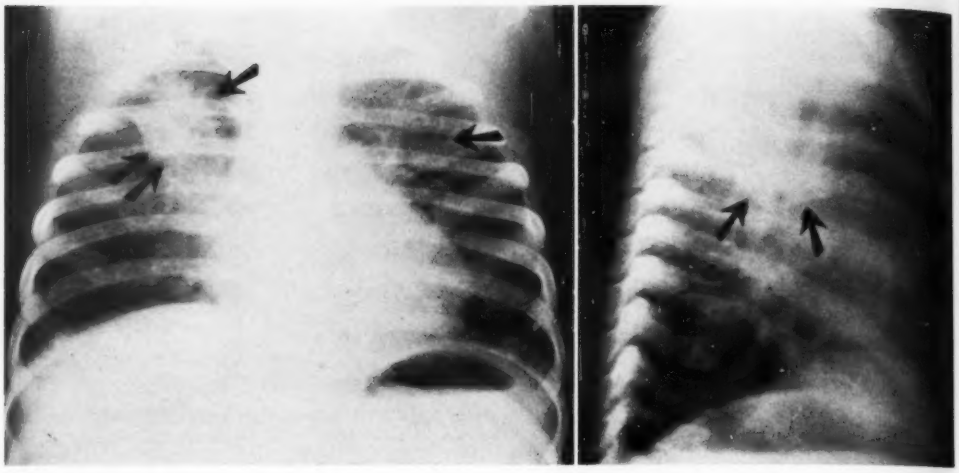

Fig. 2. The region of increased density in the right upper lobe is more homogeneous than in Fig. 1. The lower border of the opacity is smooth and convex (2 arrows). The patchy increased densities superior and medial to the opacity are probably due to pneumonia (1 arrow). There is no shift of the mid-line structures, compensatory emphysema, or elevation of the diaphragm. Three patients showed similar changes in the right upper lobe or right middle lobe. The left upper lobe is also involved but to a lesser extent (1 arrow). In the lateral view the major and minor fissures are in the normal position. These findings point more toward infection than toward atelectasis.

in 13 cases of dysautonomia with "pulmonary difficulties": chronic interstitial infiltrations more or less diffuse in both lungs, atelectasis, usually seen in the right upper lobe, and pronounced emphysema. In our series chronic infiltration of the lung was the most significant finding. Four of our patients had partial opacification of either the right upper lobe or right middle lobe which could be due to pneumonia, loculated pleural exudate, atelectasis, or a combination of these processes. We believe, however, that atelectasis contributes little to the densities seen in the lungs of this group (Fig. 2). The third finding, pronounced emphysema, was not seen in our cases.

Mild to moderate pleural reaction in the right major fissure was present in 4 patients, but no examples of gross pleural exudate were encountered. Nor was there evidence of bronchiectasis or abscess on any of the chest films. Four bronchograms were normal in patients in whom bronchiectasis was suggested clinically.

The pathogenesis of the chronic pneumonia is still unknown. In 3 patients the lungs appeared normal on early roentgenograms but later studies disclosed pneumonia, which would indicate that this finding develops after birth. Moloshok and Moseley suggest that bronchial hypersecretions lead to bronchial obstruction, with ensuing pneumonia and atelectasis. We believe that aspiration must also contribute significantly to the pathogenesis of bronchopneumonia. These children have feeding and swallowing difficulties as well as cyclic vomiting, which greatly increases the chance of aspiration. Clearing in 3 cases of bronchopneumonia occurred synchronously with improvement in the feeding and swallowing difficulties as the patient became older.

The chronic pneumonia of familial dysautonomia is to be differentiated radiographically from the chronic pneumonia of cystic fibrosis of the pancreas, and of agammaglobulinemia. In the initial stages of the pneumonia, differentiation is not possible. After a period of months to years, however, there is a difference roentgenographically in the lungs of cystic fibrosis of the pancreas and dysautonomia. In the former there are generalized peribronchial inflammatory changes throughout

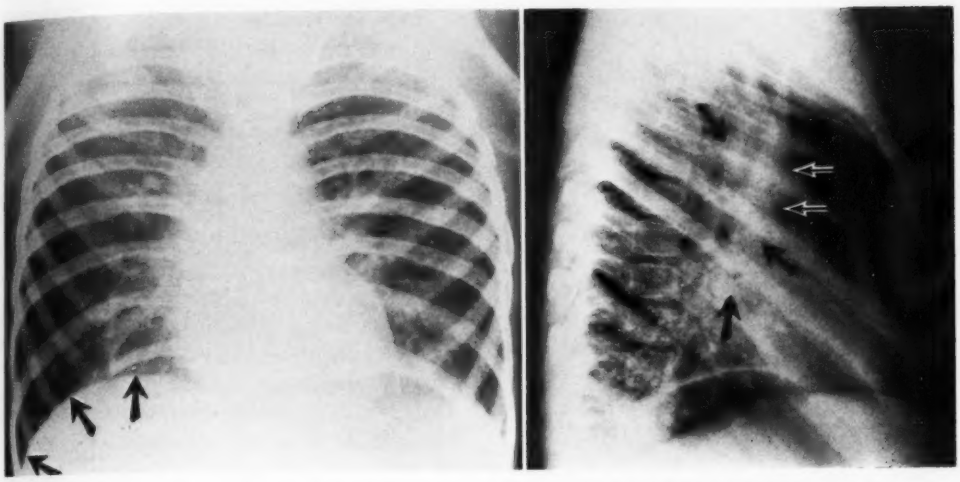

Fig. 3. Patchy and stringy increased densities are present in the perihilar portions of both lungs in a patient with dysautonomia who has had bronchopneumonia for five years. The diaphragms are normally convex (3 arrows); there is no emphysema. The arrows in the lateral view indicate the large peritracheal and peribronchial nodes.

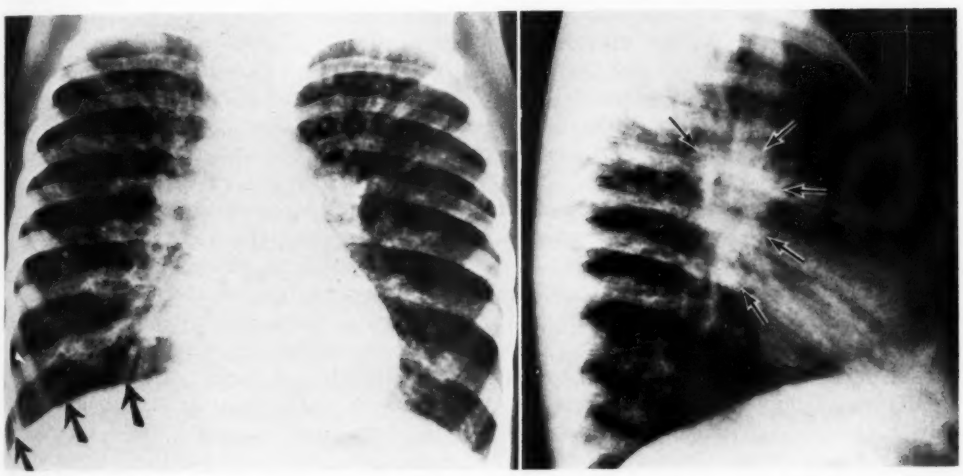

Fig. 4. Cystic fibrosis of the pancreas. The inflammatory changes involve the lungs to their most lateral portions. Emphysema is marked, with flattening of the diaphragms (3 arrows) and widening of the anteroposterior diameter of the chest. In the lateral view arrows indicate large peritracheal and peribronchial nodes.

the lungs, with marked generalized emphysema, a small heart, flat diaphragms, and an increased anteroposterior diameter of the chest. In dysautonomia the inflammatory changes rarely involve the entire lung, and there is no emphysema. The bronchiectasis seen in advanced cystic fibrosis is not present in dysautonomia. Finally, in a few cases of dysautonomia the pneumonic changes show complete clearing in follow-up roentgenograms. This is not seen in cystic fibrosis of the pancreas (Figs. 3 and 4).

In one of our cases of agammaglobulinemia with bronchopneumonia the hili were small, though one would ordinarily expect to see enlarged hilar nodes associated with pneumonitis. At necropsy both the hilar

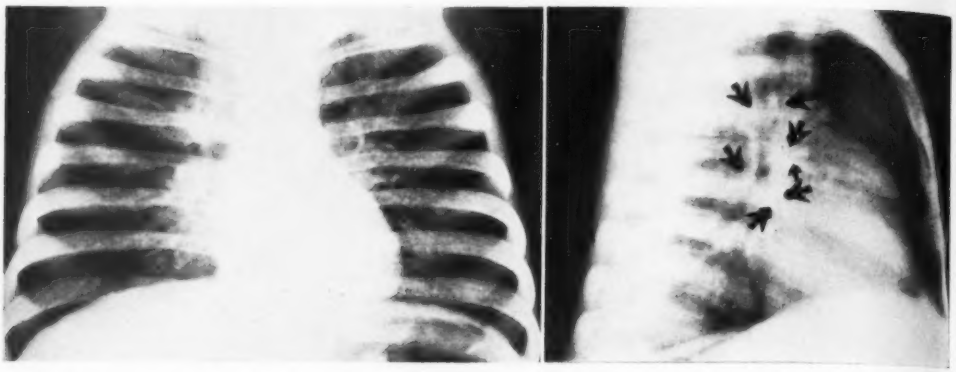

Fig. 5. Agammaglobulinemia proved clinically and at necropsy. The peritracheal and peribronchial nodes are small as demonstrated by arrows in the lateral view. The tracheal and bronchial air columns are not obscured as in Figs. 3 and 4.

nodes and those in the rest of the body were of less than normal size. Thus, in the presence of regional pneumonitis, small hili can be of help in differentiating between agammaglobulinemia and dysautonomia. Otherwise, there is no roentgenographic difference between the pneumonic processes in the two conditions (Fig. 5).

*The Skeletal System:* Riley (6) has shown retardation in height and weight to be common in dysautonomia. Skeletal maturation was measured in 16 patients, in the hand and wrist, by the standards of Greulich and Pyle (2). While it is appreciated that scoring of skeletal age is uncertain, the tendency for patients to be under the mean is fairly consistent. Seven of our patients were more than 2 standard deviations below the mean. Of the 9 within the normal range (plus or minus 2 standard deviations), 7 were less than the mean and only 2 were greater than the mean (Fig. 6).

Scoliosis and kyphosis were common occurrences; 6 of 18 patients had scoliosis and 1 had kyphosis of the thoracolumbar spine. Kyphosis was found clinically more often than roentgenographically. Scoliosis usually appears at the age of six or seven and becomes progressively worse; 3 patients, eight to fifteen years old, had very marked scoliosis. The cervical spine was normal roentgenographically in all 13 patients in whom it was examined.

Because of the poor appreciation of pain by dysautonomic patients, fractures may occur without history of trauma and without complaints of pain. Three patients with fractures of the lower extremities complained only of limp or swelling.

Two cases of ischemic necrosis occurred in this group: 1 of the tarsonavicular and 1 of the capitular epiphysis of the femur. One patient had congenital dislocation of the hip, and 1 pes cavus with metatarsus adductus. More skeletal anomalies were found in these patients than in the general child population, although there is no obvious explanation for this.

*The Gastrointestinal System:* Because of severe recurrent vomiting and/or swallowing difficulty, 8 upper gastrointestinal series were performed in 7 patients. In 6 the esophagus, stomach, and duodenum were normal. In 1 case there was pylorospasm during the first examination so that no barium passed the pylorus during a half-hour observation period. On repetition of the examination a week later, there was no delay at the pylorus; the findings were normal. All of the examinations were performed during a period when vomiting was frequent. Small-intestinal studies on 2 patients disclosed normal findings in 1 and a transit time of seven and a half hours in the other.

*The Central Nervous System:* Because the condition seems to have its origin in the

brain, the head was examined roentgenographically in 20 patients. In one the skull was enlarged; in the remainder it was normal.

Pneumoencephalograms were obtained on 3 patients, all showing normal findings. The cisterna magna was large in 2 of them. Because of hyporeflexia, poor motor coordination, and relative indifference to pain, only 1 myelogram was obtained and this was normal. So far, roentgen examination of the central nervous system and the skull has failed to reveal the cause of the disease.

*The Cardiovascular System:* Hypertension in the recumbent position was found in about 85 per cent of Riley's original group (5). It was intermittent in character, with resting blood pressures of 100/60 mm. of mercury that could rise, under situations of stress, to 160/130 mm. Such hypertension seems to be limited to children over three years of age. On standing, all of these patients so far tested show some fall in blood pressure. The heart size and contour were studied on 32 6-foot chest films obtained with the patient erect. Two patients had congenital heart disease of undetermined type. In 30 the heart appeared normal in size and contour. Twenty of this group had frank hypertension. Follow-up roentgenograms on these patients up to periods of seven years have not shown cardiomegaly.

Because of the hypertension, pheochromocytoma was considered in a number of these patients. Intravenous pyelograms on 3 were normal, and in 1 presacral aerogram the adrenals were seen to be normal. Surgical exploration in 5 cases disclosed no adrenal changes.

## DISCUSSION

There are a number of situations in which the radiologist may come in contact with familial dysautonomia. It is most frequently encountered when an infant is referred for a chest film because of fever of undetermined origin or recurrent respiratory infections. It should be considered in the differential diagnosis of chronic pneumonia in this early age group. The characteristic lung changes, which have been described above, include patchy areas of increased density, especially in the perihilar region, without emphysema or bronchiectasis. These changes may persist after disappearance of symptoms.

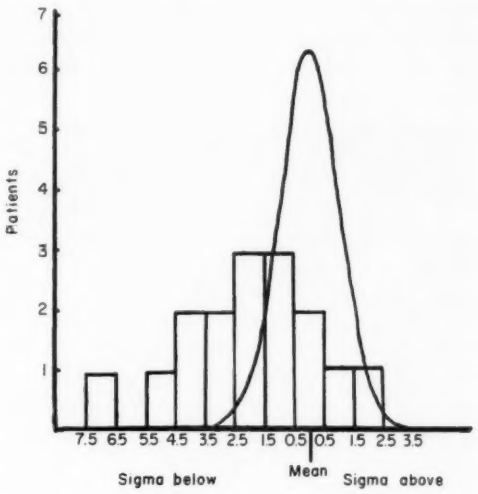


Fig. 6. Maturation of the skeleton in 16 cases of familial dysautonomia (as shown by the columns) compared with the normal distribution curve.

Reference has been made to the retardation in skeletal development and the occurrence of scoliosis, usually progressive, with marked malalignment of the thoracolumbar spine as the child grows older.

Other organs and systems show little change roentgenologically.

Hypertension, which, in a child, should always suggest dysautonomia, may initiate examinations of the chest for heart size, intravenous pyelograms and presacral aerograms. All of these examinations were normal in our series.

Gastrointestinal series may be requested because of cyclic vomiting and difficult swallowing, and these signs in an infant or child should also raise the possibility of dysautonomia, but again our findings in the digestive tract have been essentially normal.

Finally, the skull and central nervous system were examined roentgenographically because of the labile autonomic sys-

tem, indifference to pain, hyporeflexia and poor motor coordination and development. In our group, the findings were normal with a single exception.

SUMMARY

Familial dysautonomia is a clinical entity which manifests itself during the first months of life. The most significant roentgenologic changes occur in the lungs, and the radiologist should include dysautonomia among the causes of chronic infantile and juvenile pneumonias. Retarded skeletal maturation and scoliosis may be present. The heart, upper gastrointestinal tract, and central nervous system are usually normal, roentgenographically.

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SUMMARIO IN INTERLINGUA

**Constatationes Roentgenographic in Dysautonomia Familial**

Dysautonomia familial es un entitate clinic observate in infantes e juveniles, characterisate per dysfunction del systema nervose, con prominentia particular de disturbationes autonome, incluse excessos de transpiration, effluxo de salivation, transiente maculation erythematose del pelle, hypertension, incapacitate de producer lacrimas, e inadequate regulation del temperatura. Altere manifestationes es un relative indifferentia a dolores, hyporeflexia, imperfecte coordination motori, e retardo del disveloppamento skeletic. Le condition debe esser prendite in consideration in patientes pediatric con bronchopneumonia o con hypertension in le presentia de cyclos de vomito e de difficultates inglutitori.

Trenta-quatro patientes con dysautonomia familial esseva studiate radiographicamente. Le plus significative alteration roentgenologic esseva bronchopneumonia, generalmente de natura chronic, con areas disparate de augmentos de densitate, specialmente in le region perihilar, sin bronchiectasis o emphysema. Isto debe esser differentiate ab le pneumonia de morbo fibrocystic del pancreas e de agammaglobulinemia.

Le disveloppamento skeletic es retardate, e il pote haber scoliosis progressive. In le serie hic reportate, le corde, le vias gastrointestinal superior, e le systema nervose central esseva roentgenologicamente normal.

# Bone Infarcts in Sickle-Cell Anemia[1]

CAROLINE W. ROWE, M.D.,[2] and MARY E. HAGGARD, M.D.[3]

BONE INFARCTS in children with sickle-cell anemia may produce a striking radiographic picture of extreme bone destruction and rapid rebuilding. We have recently seen a case which we believe to be an excellent example of this process; in a second case, in which an initial diagnosis of osteomyelitis was entertained, the subsequent course was more suggestive of bone infarct.

The phenomenon of infarction in sickle-cell anemia has long been recognized, and aseptic necrosis resembling infarction pathologically has been described in virtually every organ and tissue of the body (6). Bone infarcts have received less attention in the literature than other features of this disease, and it is not at all certain that there is uniformity in the interpretation of certain of the bone changes, especially with regard to infarcts and osteomyelitis. Four cases, for example, similar to Case I of the present study have been reported as bone infarcts (1, 4, 9, 11), while comparable cases have been described merely as "unusual bone changes" (2, 3, 7).

One of the first accounts of bone infarcts in sickle-cell anemia was published in 1937, by Diggs, Pulliam, and King (4), who stated that patients with this disease were subject to attacks of severe bone pain with localized tenderness, fever, and leukocytosis, leading to a diagnosis of osteomyelitis and subsequent surgery; on opening the bone, however, no exudate was encountered and cultures were sterile. The authors concluded that the lesions represented bone infarcts. One patient in their series actually had a proved staphylococcal osteomyelitis in addition to sickle-cell anemia. In 1948, a series of 48 cases of sickle-cell anemia was published by Macht and Roman (9). They found bone destruction, which they called infarction, in 5 cases, involving the long bones and the metatarsals. In 1954, Tori (11) reported 102 cases of sickle-cell anemia; in 1 of these, areas of destruction in the metacarpals were believed to be infarcts.

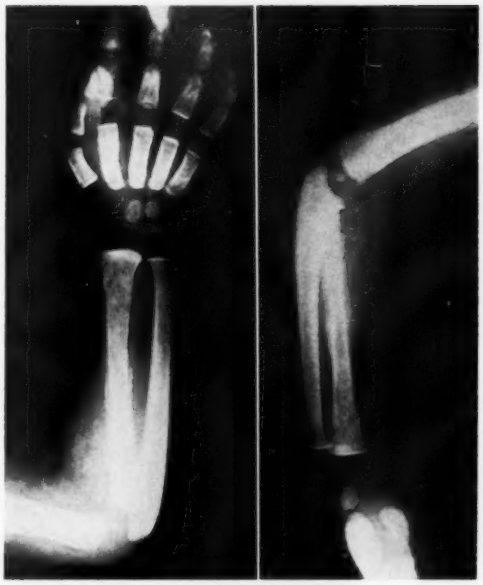

Fig. 1. Case I. Left arm; initial radiograph shows destruction of the radius and marked periosteal reaction. The same process is demonstrated in the proximal phalanx of the index finger. Periosteal reaction is evident along the humerus and the second, third, and fourth metacarpals.

It is our contention that many cases of bone infarction in individuals with sickle-cell anemia go unrecognized either because no films are made, or because of an insufficient interval between the onset of symptoms and roentgen examination. Cases in which bone lesions are discovered, on the other hand, may be mistakenly diagnosed as osteomyelitis when the lesions are in reality uncomplicated bone infarcts.

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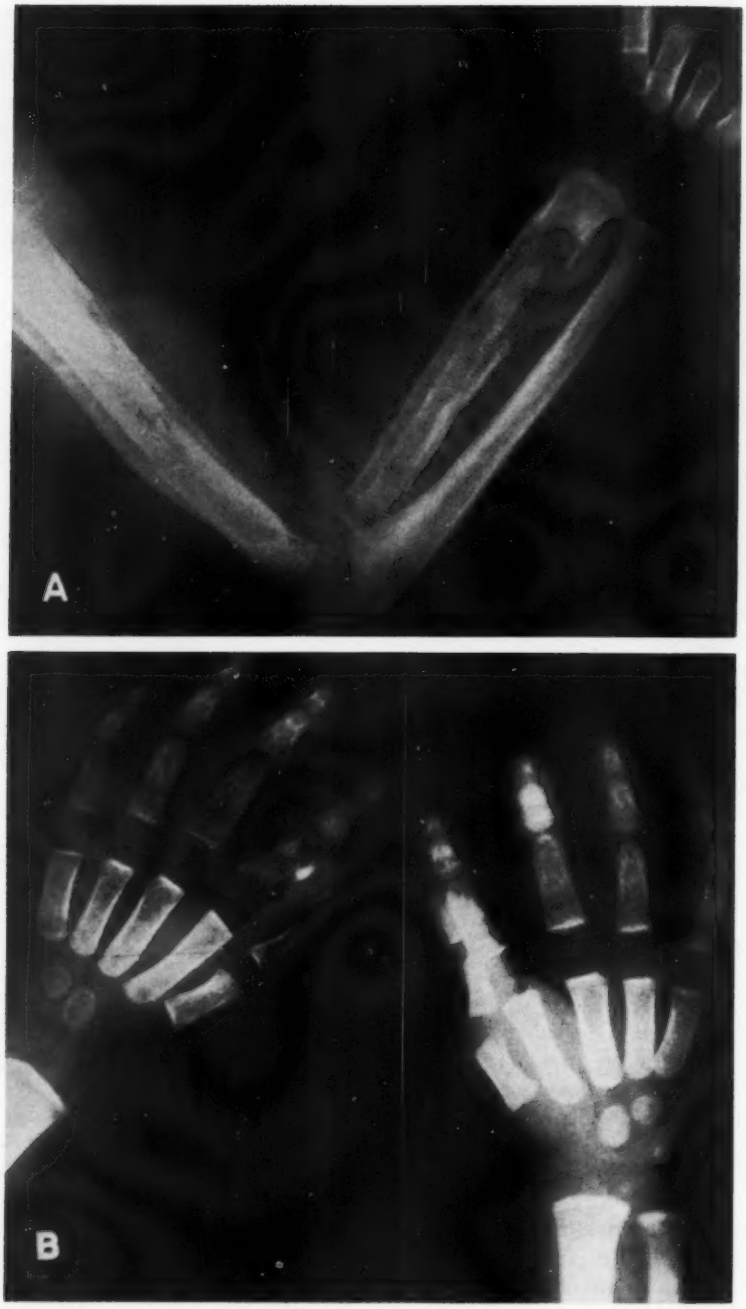


Fig. 2. Case I. A. Left arm, two weeks after Fig. 1. The destruction has progressed and there is a well developed involucrum about the radius and humerus.
B. The destruction and rebuilding of the proximal phalanx of the index finger of the left hand have progressed in identical fashion.

Fig. 3. Case I. Left arm, one month after the initial radiograph. The lesion in the radius shows a smooth-walled, oval defect at the original site of infarction.
Fig. 4. Case I. Right arm. First examination of right humerus revealed a similar lesion. It was thought to be an older infarct because of the oval shelled-out area.

## CASE REPORTS

CASE I: J. R. F., a 22-month-old Negro boy, was admitted to the hospital on Nov. 22, 1955, because of a "swollen arm." At eight months of age, he had been seen by a physician because of irritability and at that time a diagnosis of anemia was made. Swelling of the hands and feet subsequently developed, and since September 1955 the child had refused to walk. The swelling was associated with pain and tenderness and often accompanied by fever. On Sept. 22, the entire left leg began to swell, and it was still swollen on admission. There was no history of jaundice. An elder sibling was known to have sickle-cell anemia.

On *physical examination*, the child appeared irritable and listless. He was 84 cm. long and weighed 25 1/2 pounds. Both feet were swollen, as was the entire left arm and hand, without pitting edema. The mucous membranes were pale. There was no icterus. The spleen was palpated 3 cm. below the left costal margin and the liver border 2 cm. below the right costal margin. The child refused to stand or to use his left arm. He was afebrile throughout the hospital stay.

*Laboratory Data:* Blood studies showed: erythrocytes 3,210,000; hemoglobin 7.9 gm.; reticulocytes 13.6 per cent; platelets 147,660; leukocytes 12,900 with 37 per cent segmented neutrophils, 1 per cent metamyelocytes, 46 per cent lymphocytes, and 14 per cent monocytes. A sickling test was positive, and hemoglobin electrophoresis revealed only S hemoglobin with a small amount of F (6 per cent by alkali denaturation). Serologic tests for syphilis were negative. Serum proteins, phosphorus, calcium, and alkaline phosphatase were all within normal limits.

*Roentgen Examination:* A film of the upper extremities made in another hospital, Nov. 10, 1955, showed areas of bone destruction throughout the entire shaft of the left radius, with more extensive involvement at the distal metaphyseal end, and pronounced periosteal reaction. A marked periosteal reaction was also evident on the part of the humerus which was shown on this film and about some of the metacarpals. Disseminated radiolucent areas were present throughout the metacarpal area and some of the phalanges. There was bone destruction of the proximal phalanx of the index finger, with periosteal reaction and soft-tissue swelling (Fig. 1).

Thirteen days later, films of the left upper extremity revealed marked progression of the destruction of the shaft of the humerus, radius (Fig. 2A), and

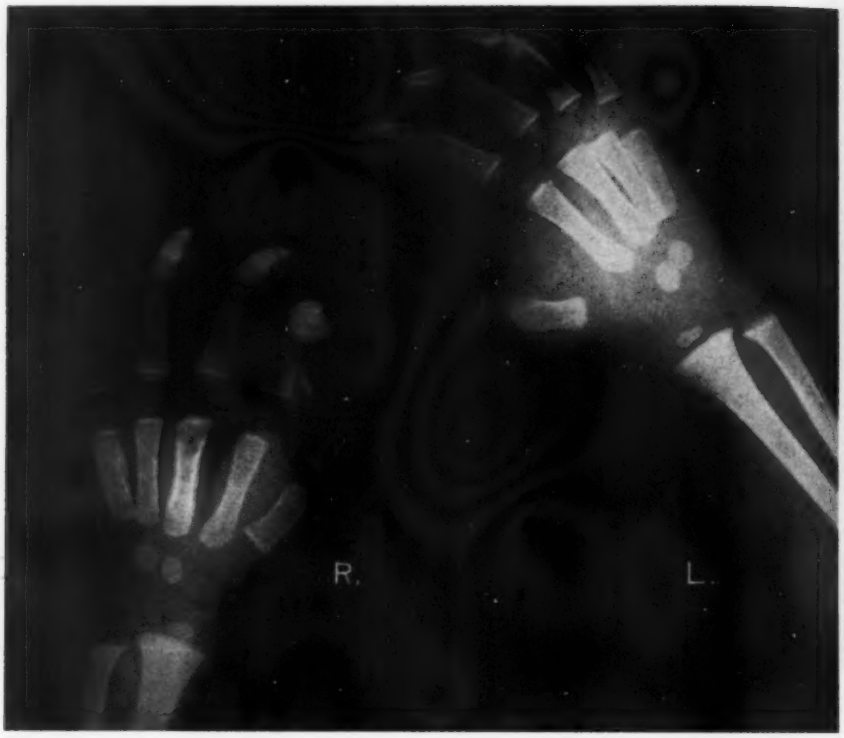


Fig. 5. Case II. Initial radiograph showing radiolucent areas in the shafts of the right third and fifth metacarpals and periosteal reaction. There is swelling of the thenar eminence of the left hand.

proximal phalanx of the index finger (Fig. 2B). There was also evidence of rebuilding of these bones so that the partially destroyed shafts were encased in a well developed involucrum. An entire bone survey made at this time disclosed another site of involvement; the right humerus was found to have an oval-shaped area of destruction in the proximal third, with periosteal reaction extending the length of the shaft (Fig. 4).

Follow-up films of the upper extremities on Dec. 7 revealed further evidence of healing of all bone lesions (Fig. 3). The left radius showed a well defined oval area of destruction with what resembled a small sequestrum in its center. The proximal phalanx of the index finger appeared to be largely new bone, with little evidence of the original shaft.

By Dec. 19, the right humerus was almost completely healed. The area of involvement now appeared to consist of a fairly dense bony structure, somewhat wider than normal, with some residual periosteal new bone formation.

*Pathologic Findings:* A biopsy specimen, obtained from the distal end of the left radius on Dec. 13, revealed considerable osteoblastic activity, with some lymphocytic infiltration in the periosteal region, resembling a chronic inflammatory reaction.

CASE II: R. S. W., a Negro female, born Dec. 14, 1954, was apparently in good health until April 1955, when her mother noticed that the sclerae were yellow. In July, dark stools were observed, and on Aug. 15, 1955, fever, cough, and vomiting developed. Physical findings at that time were: temperature 103.6°; length 69.5 cm.; weight 16 lb. 10 1/2 oz.; head circumference 45.5 cm. Generalized enlargement of the heart was detected by percussion and roentgenographically; a systolic murmur was heard over the entire precordium. The liver border was palpated 4 cm. below the right costal margin. There was no evidence of splenomegaly.

Pneumococcus was found on nasopharyngeal cultures. The blood findings were as follows: hemoglobin, 8.3 gm.; leukocytes 4,800, with 27 per cent segmented neutrophils, 12 per cent stab forms, 63 per cent lymphocytes, and 3 per cent monocytes. Cerebrospinal fluid examination was within normal limits. No other studies were done and no therapy was administered.

After three days, the child became afebrile. She remained well until Sept. 26, when the fever recurred, and the *left* hand and wrist became swollen and tender.

*Roentgen examination* of the *right* hand revealed

mottled radiolucent areas throughout the shaft of the fifth and third metacarpals, with periosteal reaction. The *left* hand showed no bone involvement at this time, but there was soft-tissue swelling of the thenar eminence (Fig. 5).

On Sept. 27, the patient was admitted to the children's ward with a temperature of 103.6° (R), pulse 168, respirations 48, and pronounced swelling of the left hand and wrist. The remainder of the physical findings had not changed markedly since the initial examination.

Fig. 6. Case II. There is improvement in the appearance of the right hand, but the left first metacarpal shows bone destruction and periosteal reaction.

A blood count now showed 3,510,000 erythrocytes; hemoglobin 8 gm.; 17,000 leukocytes, with 58 per cent segmented neutrophils, 2 per cent stab forms, 36 per cent lymphocytes; 2 per cent monocytes, and 2 per cent eosinophils. Serum bilirubin was 1.4 mg. (0.7 mg. direct; 0.7 mg. indirect). A sickling test was positive, and hemoglobin electrophoresis revealed 70 per cent S hemoglobin. Alkali denaturation demonstrated 30 per cent fetal hemoglobin. Blood cultures on Sept. 27 and 28 were negative.

Tetracycline was administered, but the daily temperature remained high (101 to 105°). On Oct. 4 an incision and drainage of an abscess in the *left* thenar space was carried out. From the purulent material obtained *Salmonella typhimurium* was cultured.

*Roentgen examination* on Oct. 13, nine days after drainage of the abscess, showed marked bone destruction of the first metacarpal on the *left*, with pronounced periosteal reaction. The soft-tissue swelling had receded somewhat (Fig. 6). Examination of the *right* hand showed the fifth and third metacarpals to be healing with a more normal bone structure, although the periosteal reaction was still apparent.

The patient became afebrile two days later and the tetracycline was discontinued. Diarrhea developed on Nov. 4, and *Shigella flexnor* was obtained from rectal culture. Sulfadiazine was then added to the therapeutic regimen.

Radiographs on Nov. 9 revealed further improvement in the appearance of the metacarpals of the right hand. There was marked restoration of normal bone structure in the left first metacarpal, although repair was not complete in the distal end (Fig. 7).

The child recovered completely from the diarrhea and was discharged asymptomatic on Nov. 10. A rectal culture one week later was negative for pathogens.

## COMMENT

In both of the foregoing cases outstanding features were the clinical and radiologic evidence of bone involvement. In Case I, the bone lesions were easily attributable to sickle-cell anemia, especially since other conditions were readily excluded by the history and serologic findings. Case II, on the other hand, was more complicated. While it was clearly a case of sickle-cell disease, the febrile course was suggestive of infection. *Salmonella typhimurium* was cultured from

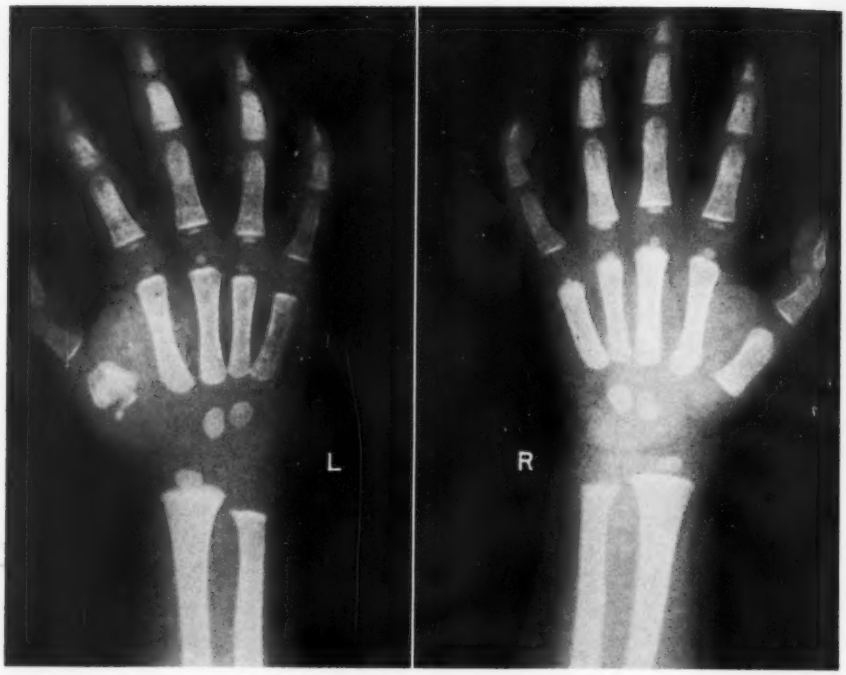


Fig. 7. Case II. Further improvement of the right hand is noted and restoration of normal bone structure in the left first metacarpal is seen to be taking place.

a thenar abscess, and the possibility of osteomyelitis must certainly be considered. Although others (5) have also encountered this complication in sickle-cell disease, it seems unlikely that our patient was suffering from osteomyelitis. Blood cultures were repeatedly negative. Bone lesions were first observed in the right hand, which never showed soft-tissue swelling. When, later, a similar bone lesion developed in the left hand, which was the site of soft-tissue infection, no communication between the bone lesions and the soft-tissue abscess could be demonstrated. Moreover, other investigators (1, 4, 9, 11) have observed lesions resulting from "bone infarcts" which radiologically resembled those in Case II.

## DISCUSSION

The first report of a pathologic study of bone changes in sickle-cell anemia was by Graham (6) in 1924. He described a condition consisting essentially of chronic infectious or toxic injury to the marrow and medullary bones with subsequent repair processes and compensatory hyperplasia. Among his observations was focal necrosis, destroying soft tissues and injuring trabeculae. Necrotic marrow was replaced by loose granulation tissue, and bone repair was also evident. In 1953, Reich and Rosenberg (10) described the pathophysiology of bone changes occurring in sickle-cell anemia. They believed that many of the roentgen changes were due to sclerosis on the basis of bone infarcts. The rigidity and increase in viscosity of sickle-cell blood, as well as the congestion, stasis, and necrosis reported by others, strongly suggest thrombosis with infarction.

The exact mechanism by which the infarction develops remains obscure. While some investigators consider it a sequel to emboli, others (8) question this, and suggest that pathologically, only vasospasm may be demonstrated. Biopsy material

obtained in Case I supports Graham's observations in that there was lymphocytic infiltration suggestive of chronic inflammation and intense osteoblastic activity indicating new bone formation.

It has been observed by the present authors, as well as by others, that radiologically detectable bone changes may lag two to three weeks behind the onset of clinical signs and symptoms. In the normal tubular bone, the compact cortex is responsible for most of the density seen on the radiograph. Since the shadow cast by normal bone spongiosa is relatively faint, it seems apparent that severe changes may develop here before being detected on the roentgenograms. Macht and Roman noted a time difference in the appearance of symptoms and radiographic findings as great as twenty-one days; 2 cases in which the initial films were negative showed evidence of destruction of the marrow and cortex three weeks later. Danford, Marr, and Elsey (3) reported the case of an eight-month-old child in which the x-ray film was negative on the eighth day of illness but on the sixteenth day showed bone changes in the hands. The patient was followed over a period of four months; the lesions gradually disappeared, with complete healing after twenty-seven days.

The initial radiologic picture of bone involvement consists of patchy areas of destruction in the spongiosa with periosteal reaction. Subsequently, there appears to be a complete rebuilding of the shaft, while the original shaft is ultimately completely absorbed. In following Case I, we felt that original sites of involvement which developed as oval-shaped, smoothly shelled-out bone defects were significant in representing bone infarcts.

In the early stages of development it may be impossible to distinguish the radiographic features of bone involvement in uncomplicated sickle-cell disease from those found in osteomyelitis, congenital syphilis, metastatic malignant disease, Ewing's sarcoma, leukemia, or even tuberculosis. The fact that multiple bone involvement occurs frequently narrows the field of diagnostic possibilities when the case is first encountered. Congenital syphilis can be excluded by serologic tests; osteomyelitis remains the condition most difficult to differentiate. If it is known, however, that the patient has sickle-cell anemia, and there is no clinical evidence to support the diagnosis of osteomyelitis of several bones, one should be alert to the possibility that the condition may be uncomplicated bone infarct.

## SUMMARY

Bone infarcts in children with sickle-cell anemia apparently occur infrequently, few reports having been found in the literature. In this paper, 2 cases are presented in which multiple bone infarcts were diagnosed. In 1 of these the complication of osteomyelitis was considered but was not confirmed. Possible mechanisms of development of infarcts in sickle-cell disease are reviewed.

The radiographic appearance of bone infarcts and the time interval between onset of symptoms and appearance of radiological findings are discussed. The roentgen findings are thought to be typical, although not specific in a single bone. The interval of two to three weeks which apparently must elapse before the radiographic changes become evident is probably responsible for the paucity of recorded cases.

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SUMMARIO IN INTERLINGUA

**Infarctos Ossee in Anemia a Cellulas Falciforme**

Le autores presenta 2 casos de anemia a cellulas falciforme in que multiple infarctos ossee esseva diagnosticate. In caso I, le lesiones ossee esseva facilemente attribuibile a anemia a cellulas falciforme, in tanto que altere conditiones habeva essite promptemente excludite super le base del historia del patiente e super le base de constatationes seriologic. In caso II, le possibilitate de osteomyelitis esseva brevemente considerate. Le curso febril que characterisava iste caso pareva suggerer le presentia de infection, e *Salmonella typhimurium* esseva culturate ab un abscesso thenar. Nonobstante, le conclusion esseva que le lesiones representava etiam infarctos ossee.

Le autores assere que multe casos de infarctos ossee associate con anemia a cellulas falciforme non es recognoscite proque studios roentgenologic non es interprendite o proque insufficiente intervallos de tempore ha passate inter le declaration del symptomas e le examine roentgenologic. Alterationes ossee que es radiologicamente detegibile pote tardar duo a tres septimanas post le declaration del signos e symptomas clinic. In normal ossos tubular, le compacte cortice es responsabile pro le plus grande parte del densitate vidite in le roentgenogramma. Proque le umbra effectuate per normal substantia spongiose es relativemente leve, il pare plausibile que sever alterationes pote disveloppar se in ille substantia ante que illos es roentgenographicamente apparente.

Le imagine radiographic initial de affection ossee consiste de areas disparate de destruction in le substantia spongiose con reaction periosteal. Subsequentemente, un reconstruction complete del diaphyse es apparente, durante que le diaphyse original es totalmente absorbite in le curso del tempore. Durante le prime stadios, il es a vices impossibile distinguer le apectos radiographic del affection ossee in non-complicate morbo a cellulas falciforme ab illos trovate in osteomyelitis, syphilis congenite, morbo maligne metastatic, sarcoma de Ewing, leucemia, o mesmo tuberculose. Le facto que affectiones multiple del ossos occurre frequentemente restringe le campo del possibilitates diagnostic. Syphilis congenite pote esser excludite per tests serologic, de maniera que osteomyelitis remane como le condition que es le plus difficile a eliminar. Si le presentia de anemia a cellulas falciforme es establite, e si il ha nulle supporto clinic pro un diagnose de osteomyelitis, non-complicate infarcto ossee debe esser suspicite.

# Ulcerative Jejunitis in Polyarteritis[1]

ALICE ETTINGER, M.D.,[2] and RUHERI PEREZ-TAMAYO, M.D.[3]

THE ROENTGEN findings of ulcerative enteritis have not previously been described in patients with polyarteritis. In the case to be reported here such findings, evaluated together with the clinical findings, contributed to the correct diagnosis.

The term polyarteritis is synonymous with periarteritis nodosa. Recently McCombs, Patterson, and MacMahon discussed a group of patients who showed inflammation of small blood vessels but did not, in their opinion, exhibit the classical features of periarteritis nodosa in the original sense of the term (1). They have proposed the term "allergic" vasculitis for such a condition and believe there may be both fatal and non-fatal variants of the disease (2). The case we are about to describe has been designated by McCombs and his associates as one of fatal "allergic" vasculitis.

Polyarteritis belongs to the group of "collagen" diseases. Rich (3) reported its incidence at Johns Hopkins Hospital as 1 case in 137 autopsies from 1936 through 1944. It is three times more common in males than in females. The onset is between the ages of twenty and fifty years. The clinical course may be prolonged or rapidly progressive, with death within a few weeks. In either course many organs are involved in the disease process. Polyarteritis may also occur as a "localized" form limited to a single organ. As a rule, the diagnosis of the "localized" type is established only after histologic examination of the removed organ (4–6).

Clinically, patients with diffuse polyarteritis display constitutional symptoms such as fever and weight loss, in addition to the more specific manifestations, depending on the organs involved. The kidneys, lungs, heart, nervous system, and entire gastrointestinal tract may be affected, and anyone of them may produce symptoms that dominate the clinical picture. Gastrointestinal symptoms are present in a high percentage of cases, according to the literature.

Harris (5) reported abdominal pain in 57 per cent of 101 cases of periarteritis nodosa. Of Wold and Baggenstoss' (7) series of 30 patients, 76 per cent had abdominal symptoms: Pain was present in 70 per cent, anorexia in 57 per cent, distention in 23 per cent, nausea in 13 per cent, hematemesis in 10 per cent, diarrhea in 3 per cent, and jaundice in 10 per cent. At times abdominal symptoms are those of an acute catastrophe.

The macroscopic lesions found in the gastrointestinal tract consist in infarcts, hemorrhages, ulcerations, and perforations of the intestinal wall. Ulcerative enteritis has also been reported as a pathologic finding (8). Wold and Baggenstoss found macroscopic involvement of the gastrointestinal tract in 69.9 per cent of their series.

Microscopically the characteristic lesion is in the wall of the vessels. It is characterized by edema, eosinophilic infiltration and necrosis, fibrinoid degeneration, and fibroblastic proliferation. The gross findings mentioned above are the direct result of the ischemia secondary to vascular damage. Various stages of inflammation and healing may be seen in the media (9).

The roentgen findings thus far reported in the collagen diseases have been summarized by Garland and Sisson (10) in an excellent paper. In the section on polyarteritis they describe mainly the pulmonary findings. Regarding the gastrointes-

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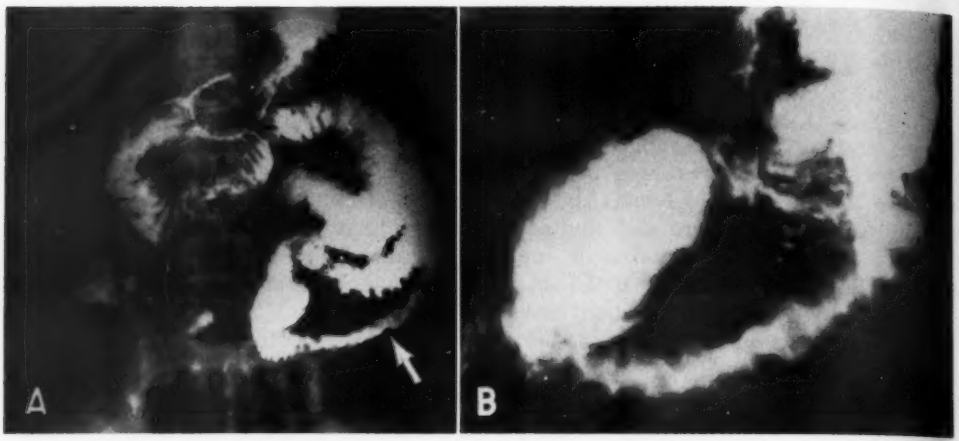


Fig. 1. A. Supine film showing several dilated jejunal loops proximal to narrow ulcerated jejunal segment (arrow).
B. Spot-film showing ulcerated jejunum to better advantage.

tinal tract, they state: "The abdominal films usually show either no abnormality or some gas collections suggesting paralytic obstruction (so-called adynamic ileus). Very rarely, there may be a perforated ulcer, intestinal infarction or pancreatic necrosis." Apparently in their series adequate roentgen examinations of the gastrointestinal tract were not carried out, although records of chest examinations were available in 28 of their 29 cases.

The case to be reported here offers a new roentgenological observation of gastrointestinal changes in polyarteritis.

## CASE REPORT[4]

A 57-year-old man entered New England Center Hospital because of nausea and diarrhea. Six weeks before admission a rash had appeared on the dorsum of the hands, and two weeks later migratory polyarthritis, hematemesis, abdominal cramps, and bloody diarrhea developed. He also noticed that the sputum was occasionally blood-tinged.

*Physical Examination:* The temperature was 98.0° F., pulse 88, blood pressure 110/58. The patient was a small but well nourished man appearing pale and chronically ill. There were dullness to percussion, decreased tactile fremitus, and breath sounds at the right lung base. The rectum contained dark material which was guaiac-positive. Proctoscopy to 25 cm. showed no abnormalities.

*Laboratory Studies:* On admission the blood findings were: hemoglobin 11.4 gm./100 c.c., hematocrit 38.5 per cent, leukocyte count 12,000 (73 per cent polymorphonuclears, 17 per cent lymphocytes, 10 per cent monocytes), platelets and red blood cells normal, sedimentation rate 25 mm. in an hour (Westergren), total serum protein 4.0 gm. per cent (albumin 2.0, globulin 2.0), serum bilirubin 0.1 mg. per cent. The specific gravity of the urine was 1.018; tests for sugar and albumin were negative; the sediment contained 3 to 5 leukocytes per high-power field.

*X-ray Studies:* Chest film on admission showed a right pleural effusion. A barium enema study was negative. An upper gastrointestinal series showed some irregularity of the descending duodenum.

*Course:* The patient continued to have bloody diarrhea. Thoracentesis on the right produced 500 c.c. of grossly bloody fluid, negative cytologically. In the course of his hospital stay the patient was given several blood transfusions because of continued fall of the hematocrit. Generalized purpuric spots appeared. The most important development, however, was acute renal insufficiency with oliguria and uremia.

On the twenty-sixth hospital day, after the occurrence of severe epigastric pain and hematemesis, a repeat gastrointestinal examination was done. The duodenal changes previously described were less striking, but two ulcerated, somewhat narrow jejunal loops were seen (Fig. 1 A and B). The roentgen report stated that the findings of ulcerative jejunitis might well be explained on the basis of polyarteritis, in view of the clinical findings. The roentgen find-

[4] The discussion of this case in a Clinicopathologic Conference appears in the *Bulletin* of Tufts-New England Medical Center **2**: 48–54, January–March 1956. The pathological diagnosis was made by Drs. H. E. MacMahon and Gherardo J. Gherardi, Professor and Associate Professor, respectively, of Pathology, Tufts University School of Medicine.

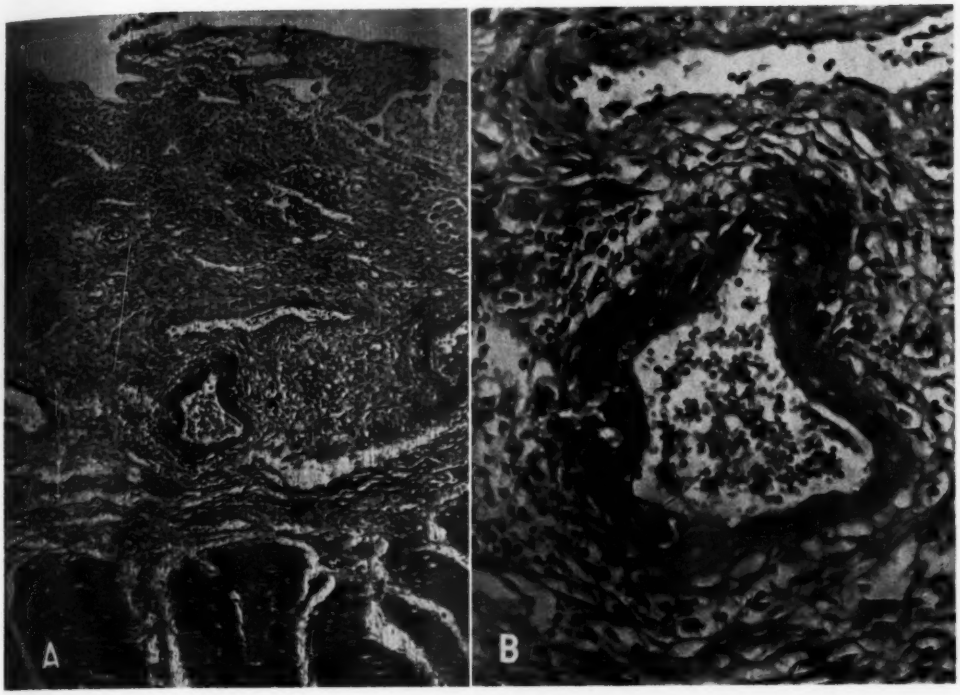


Fig. 2. A. Small-bowel wall showing an acute inflammatory process centered about a small artery, with accompanying inflammation of the entire wall and mucosal ulceration.
B. The eccentricity, focal nature, and necrotizing quality of the process are evident in a high-power view of the same vessel.

ings *per se* were similar or identical with those of an acute stage of regional enteritis.

On ACTH therapy the patient's renal status improved, but he died in shock on the seventy-fourth hospital day, with symptoms indicating an abdominal catastrophe.

*Autopsy Report:* The cause of death was an acute generalized fibrinous peritonitis, secondary to perforation of the jejunum. The jejunum just beyond the duodenum was dark red, with a thickened wall and a ragged, heaped-up mucosa. It showed a clearly defined perforation 0.4 cm. in diameter and, in the area about this, multiple small but grossly visible ulcerations extending over a distance of approximately a foot. The excrescences previously described appeared, on close examination, to be areas of surviving mucosa which had not sloughed. The mucosa from the stomach to the sigmoid colon was riddled with small hemorrhages.

The basic disease was a generalized vasculitis. The vessels involved were small and medium-sized arteries, which showed an acute necrotizing inflammatory reaction (Fig. 2 A and B). Besides the gastrointestinal tract, the vascular changes were observed mainly in the lungs and kidneys. A progressive non-suppurative focal glomerulitis was present.

*Pathologic Diagnosis:* "Allergic" vasculitis involving intestinal tract, lungs, and kidneys, with perforation of jejunum and peritonitis.

## DISCUSSION

It is apparent that many of the macroscopic lesions seen at autopsy in polyarteritis do not lend themselves to roentgen recognition. Mucosal and submucosal hemorrhages, ischemia not leading to necrosis, scattered single ulcerations, and minimal localized lesions cannot be detected by radiologic methods. Only an ulcerative enteritis such as Jernstrom (8) has reported can be expected to produce roentgen signs. Our case is an example of such an enteritis.

Jernstrom stated that there are no data available in the pathologic literature concerning the frequency of grossly inflammatory, ulcerated intestinal lesions in polyarteritis. It is uncertain, therefore, how often roentgen examination of the gastro-

intestinal tract may be able to contribute to the diagnosis of polyarteritis, or "allergic" vasculitis. As far as we know, no case of an inflammatory ulcerative lesion of the intestinal tract diagnosed radiologically has been reported in the literature. Geist (11), however, observed small bowel changes in a case of Wegener's granuloma associated with polyarteritis. He stated: "Barium studies of the small intestine revealed multiple, dilated, edematous loops similar in appearance to mesenteric thrombosis, sprue or passive congestion." No statement regarding intestinal ulcerations was made. Our case does not correspond to Geist's description, although the appearance of the bowel in his illustration suggests common features.

There have been roentgen observations of gastrointestinal abnormalities in other collagen diseases, as in scleroderma (12), and in such related diseases as Henoch-Schoenlein's purpura (13). On the basis of pathological findings, it stands to reason that, in the future, abnormalities of small bowel pattern may also be detected in lupus erythematosus (14).

## CONCLUSION

Although there has been an increasing awareness of the variety of clinical symptoms in polyarteritis, the individual case may offer considerable difficulty in diagnosis.

The present case report appears to indicate that in some obscure cases of polyarteritis exhibiting gastrointestinal symptoms, the roentgen demonstration of ulcerative lesions of the small intestines may aid in establishing a correct diagnosis.

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## SUMMARIO IN INTERLINGUA

### Jejunitis Ulcerative in Polyarteritis

Es reportate un roentgeno-constatation in polyarteritis que non ha previemente essite describite in le litteratura. Un patiente con datos clinic que suggereva polyarteritis presentava un tableau roentgenologic de jejunitis ulcerative simile a illo del stadio acute de enteritis regional. Le patiente moriva ab un acute peritonitis fibrinose secundari a perforation del jejuno. Al necropsia il esseva constatate que le morbo fundamental esseva un "allergic" vasculitis generalisate.

Es suggerite que observationes roentgenolic de tal affectiones intestinal pote esser de adjuta in establir un diagnose in certe casos obscur de polyarteritis.

# Gastrointestinal Roentgen Findings Due to Untoward Effects of Hexamethonium[1]

IRVING K. ETTMAN, M.D., C. D. BOUCHILLON, M.D., and H. H. HALFORD, M.D.

THE PHARMACOLOGY of hexamethonium has been known for a number of years, and its physiologic activities are familiar to those who are concerned with the management of the severely hypertensive patient. Recently the drug has come into wider use, and indications are that it is frequently given to clinical out-patients. In any group of ambulatory patients treated on an out-patient basis there will always be a certain number who, for various reasons, do not receive adequate observation and supervision. For this reason it is of importance that the potency of the drug be fully appreciated.

Several interesting cases have recently been observed by the present writers in the Radiology Department of their hospital, illustrating some of the problems and potential hazards encountered with the use of hexamethonium. We are primarily concerned here with the untoward effects on the gastrointestinal tract as demonstrated by roentgenographic and fluoroscopic examination. The early recognition of these side-effects can be of great help in averting more severe reactions. Of paramount concern is the recognition of gastric retention and adynamic ileus.

## PHARMACOLOGICAL PROPERTIES OF HEXAMETHONIUM

Hexamethonium is similar in its action and uses to salts of other quaternary ammonium compounds which act as ganglionic blocking agents. It inhibits the transmission of nerve impulses through both sympathetic and parasympathetic ganglia of the autonomic nervous system (4). By the above action, it causes generalized vascular relaxation, dilatation, and hypotension and so finds its chief use in medicine today in the treatment of hypertensive vascular disease. In the gastrointestinal tract it produces gastric hypotonicity and hyposecretion of both the acid and mucous elements, and it has therefore been used in the treatment of peptic ulcer.

The gastrointestinal tract receives dual and reciprocal innervation from the two divisions of the autonomic nervous system. Intestinal function is largely dependent on maintenance of a balance between the sympathetic and parasympathetic components of the autonomic system. Under ordinary circumstances, the parasympathetic impulses cause increased motility and the sympathetic decreased motility (3). Ganglionic blocking agents produce striking dilatation and decreased motility in the human stomach, small intestine, and colon, lengthening the emptying time. With such a long-acting drug as hexamethonium gastrointestinal inactivity may last for hours. The bowel, however, does remain responsive to laxative measures. Ganglionic blocking agents decrease the secretion of gastric fluid and acid in man. The recognized side-effects of hexamethonium are as follows.

A. Milder responses
   1. Visual disturbances
   2. Dry mouth
   3. Conjunctival suffusion
   4. Moderate constipation
   5. Occasional diarrhea
   6. Abdominal discomfort, etc.

B. More severe reactions
   1. Marked hypotension
   2. Obstipation
   3. Paralytic ileus
   4. Urinary retention
   5. Unexpected pulmonary changes (organized fibrinous edema), thought to be secondary to attacks of left heart failure associated with resulting intermittent hypotension
   6. Gastric retention

Gastric retention and adynamic ileus can

[1] From the Radiology Service, Kennedy Veterans Administration Medical Teaching Group Hospital, Memphis, Tenn. Accepted for publication in November 1956.

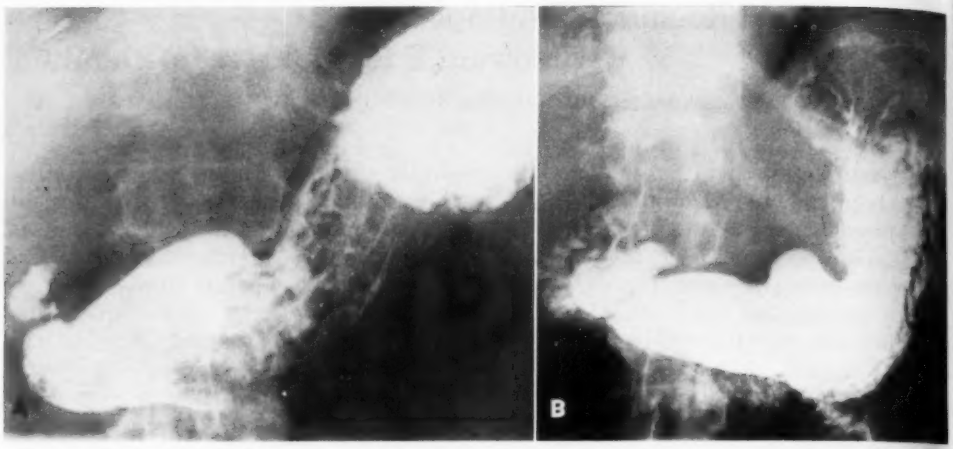

Fig. 1. Case I. A. Multiple polypoid defects in the antral portion of the stomach. Patient on hexamethonium therapy.
B. Hexamethonium in the stomach nine days later. No food taken for three days prior to examination. Polypoid defects again noted, simulating polypoid neoplasm.

be recognized on the scout film of the abdomen.

Douthwaite and Thorne (2) studied the effects of hexamethonium on the stomach by giving 100-mg. doses to 10 patients and were able to demonstrate delay in the onset of gastric evacuation for periods of thirty minutes and delay in completion of emptying until the sixth hour. Gastric peristalsis was diminished but not completely inhibited. There was no change in the shape of the stomach. The small bowel, particularly the duodenum and the jejunum, was dilated and immobile for periods up to six hours after administration of the drug. Gastric secretion was only slightly altered. The changes noted above were observed by us during fluoroscopy and on the roentgenograms of patients receiving hexamethonium therapy for hypertension. In one of our cases, decrease in gastric secretion was severe.

Holt (5) and others, in their reports on altered alimentary function following the administration of tetraethylammonium, mention a diminution of gastrointestinal tone and cessation of motility in the small bowel. Tetraethylammonium has the disadvantage, therapeutically, of short duration of action, lack of sufficient selectivity, and disturbing side-effects. It has been replaced by hexamethonium, which is ten times as potent, with effects lasting three or four times as long.

Morrow *et al.* (6), in their study of the side-effects of hexamethonium, found constipation to be the most troublesome complaint; suppression of intestinal motility was observed in every case in their series. When inadequate attention was given to the bowel, constipation progressed to adynamic ileus, which was reversible unless a coexistent mechanical obstruction due to organic disease was present.

## CASE REPORTS

The following cases are presented to show the value of roentgenograms in the early detection of the untoward side-effects of hexamethonium:

CASE I: J. G., a 59-year-old colored male, was admitted to Kennedy VA Hospital for the first time on May 17, 1955, with malignant hypertension. His complaints on admission were loss of appetite, nausea, generalized weakness, and a weight loss of approximately 30 pounds over a period of six months. Blood pressure on admission ranged from 260 to 280 systolic and 150 to 170 diastolic; blood urea nitrogen was 85 mg. per cent. The patient was given Veriloid intramuscularly and showed some response, as indicated by a drop in blood pressure. The drug was discontinued on June 9, and Provell was given from that date to June 15, when intramuscular administration of hexamethonium

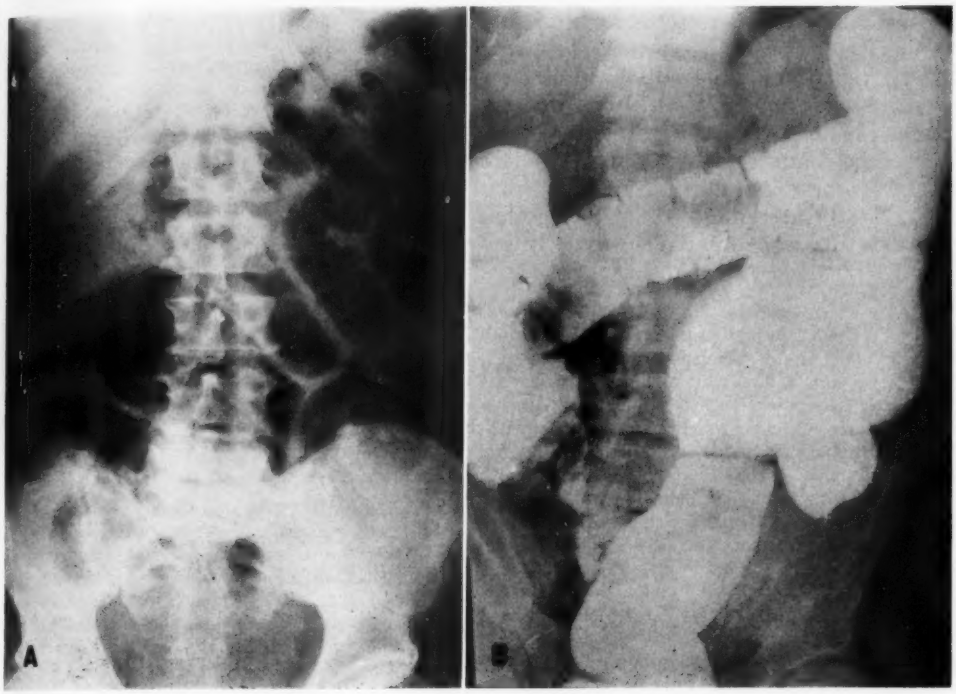


Fig. 2. Case II. A. Scout film consistent with intestinal obstruction. Clinically, mechanical obstruction suspected. X-ray diagnosis: adynamic ileus secondary to hexamethonium therapy.
B. Film obtained following supportive therapy. Barium enema reveals no organic lesion of the colon.

(Methium) was begun. This was continued until July 20, the dosage being gradually increased to a maximum of 100 mg. every six hours. On June 28, 1955, a gastrointestinal examination was done because of severe nausea and vomiting and cramping upper abdominal pain. This study (Fig. 1A) revealed multiple radiolucent filling defects in the stomach, which were interpreted as possible particles of food or polyps. On repetition of the examination on July 6, the findings were unchanged (Fig. 1B). Gastroscopy showed the radiolucent areas to be due to multiple tenaciously adherent food particles.

On July 15, clinical evidence of heart failure developed and the patient was digitalized. The blood pressure tended to resist therapy, and the patient became progressively worse. He died on July 22.

Pertinent autopsy findings were generalized arteriosclerosis; bilateral arteriolar nephrosclerosis; severe cardiac hypertophy, principally left ventricular; congestion of the liver, spleen and kidneys; bilateral pulmonary edema. Gross and microscopic examination of the stomach failed to reveal any evidence of pathologic change. Microscopic examination of the lungs revealed thickened alveolar walls, primarily dilated from the engorged capillaries. Some fibrosis was also noted. The alveolar spaces contained scattered pigment-laden macrophages with occasional leukocytes surrounded by edema fluid. Some alveoli showed a slight degree of hemorrhage.

This case demonstrates the effects of hexamethonium therapy in inhibiting gastric motility and secretions, resulting in retention of food particles in the stomach for over a week. In this case, secretions were markedly reduced, with consequent adherence of the particles to the mucosa. The small radiolucent filling defects which were present on repeated roentgen examinations, especially with presenting symptoms of nausea, vomiting, loss of weight, and abdominal discomfort, which are the milder of the side-effects of hexamethonium, may be difficult to differentiate from organic lesions of the stomach. These findings can be ascribed to the effects of hexamethonium in reducing gastric motility and suppressing gastric secretion.

The findings in the lungs are similar to

those described by Doniach, Morrison, and Steiner (1). The changes consist in mixed intra-alveolar and interstitial fibrosis associated with preservation of normal alveolar elastic pattern. These authors feel that these changes are due to one or more bouts of fibrinous pulmonary edema, and are not to be attributed to the hexamethonium, as they were observed in only 3 out of 54 patients.

CASE II: A. K., a 53-year-old colored male, was hospitalized with hypertension of 186/120, cardiomegaly, myocardial insufficiency, and arteriolonephrosclerosis. For a month he was under treatment with various hypotensive drugs, including Apresoline, Serpasil, Veriloid, Provell, and sedatives, without appreciable response. On Aug. 3, 1956, oral administration of hexamethonium was begun, with doses of 125 mg. every six hours. Two days later the dose was increased to 250 mg. at six-hour intervals. On Aug. 8, after two days of constipation, clinical signs of ileus developed, with no audible peristalsis and pronounced abdominal distention.

Roentgen examination (Aug. 8) revealed marked distention of the small bowel with several air-fluid levels (Fig. 2A). There was separation of bowel loops suggesting thickened walls or separation due to fluid. The possibility of small bowel obstruction on a mechanical basis was considered. The patient was cautiously treated with Prostigmine and frequent enemas, and the dose or hexamethonium was reduced to 125 mg. every six hours. On Aug. 14, the clinical evidence of ileus was gone and a barium enema study was reported as negative (Fig. 2B). Since then, the patient's dose of hexamethonium has been gradually increased. There has been a marked tendency to constipation, which is combated with regularly scheduled enemas and magnesium sulfate, Urecholine, and Doxinate to keep the stools soft.

This case is an example of severe adynamic ileus due to hexamethonium. As pointed out by Morrow, Schroeder, and Perry (6), constipation, unless controlled during hexamethonium therapy, will progress to ileus because of the marked suppression of intestinal motility. Indeed, in this case mechanical obstruction was simulated. The administration of stimulating laxatives and Urecholine served to control constipation.

Adynamic ileus resulting from hexamethonium should be considered in the differential diagnosis of ileus, especially in the age group in which hypertension is common.

CASE III: M. C., a 43-year-old colored male with blood pressure of 220/112 and renal arteriosclerosis, had been under treatment with sedatives and numerous anti-hypertensive drugs without significant effect. On July 16, 1956, oral administration of hexamethonium, 125 mg. every six hours, was begun. On July 19 the patient complained of a sense of fullness, and the abdomen was distended. A roentgenogram obtained that day (Fig. 3A) revealed extreme dilatation of the stomach, which showed a large volume of retained secretions and food particles. During an attempt to pass a stomach tube for decompression, a large amount of vomitus was expelled, containing many particles of food. The following day there was clinical improvement and a scout film of the abdomen showed the stomach and intestinal tract to be within normal limits (Fig. 3B). The patient, meanwhile, had continued to receive lower doses of hexamethonium. On July 24, the dosage was increased to 250 mg. every four hours for a blood pressure (systolic) above 140. On Sept. 10, the dose was raised to 500 mg. every four hours orally, the blood pressure having risen to above 150 systolic, where it remained constant. Clinical and radiologic evidence of adynamic ileus appeared on Sept. 14. The patient again responded to Prostigmine, Urecholine, and enemas, and the high dose level of methonium has been continued.

The above case demonstrates gastric retention and adynamic ileus as serious untoward effects of hexamethonium during hypertensive therapy; early recognition can prevent serious complications. The gastric retention can be observed on a film of the abdomen even before symptoms are suggested clinically. The clinician was unaware of the retention of hexamethonium in the stomach and repeated oral administration, with a consequent toxic accumulation. When the contents of the stomach pass into the duodenum, the drug may be absorbed in toxic amounts, and the serious complication of hypotension and collapse may ensue. The latter possibility cannot be overemphasized.

## SUMMARY

Hexamethonium has become more widely used in the management of severe hypertensive patients than previously. It is a potent autonomic blocking agent, and the hazards involved in its use must be constantly considered. The rather striking and easily demonstrated gastrointestinal complications which can and do occur

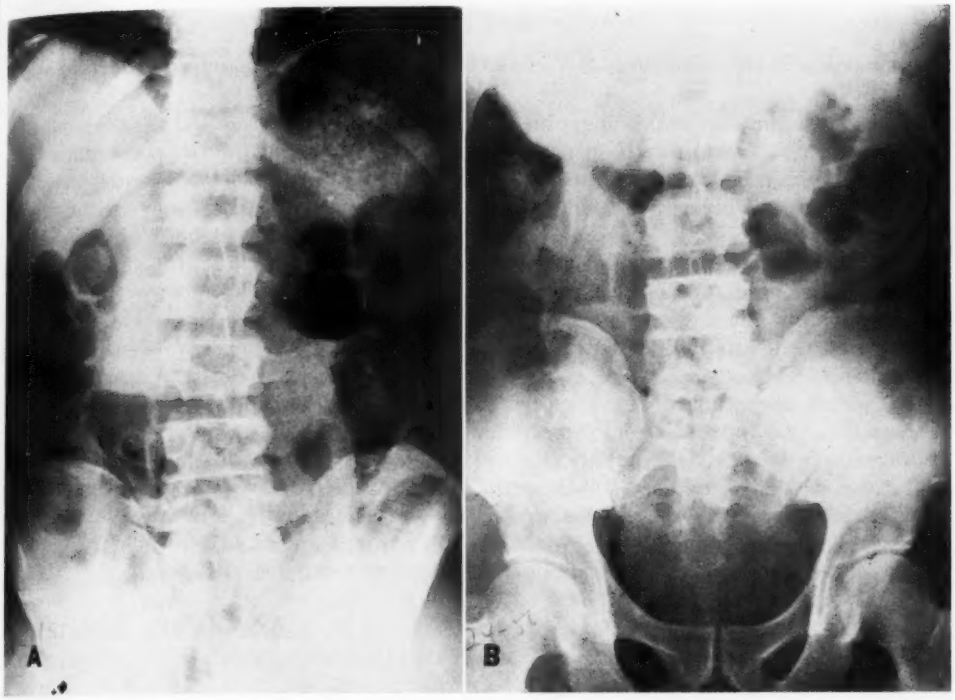


Fig. 3. Case III. A. Marked gastric retention and dilatation of the small and large intestines. Roentgen diagnosis: adynamic ileus secondary to hexamethonium effects.
B. Film obtained following evacuation of stomach and supportive measures. Marked clinical improvement. Hexamethonium therapy continued.

with its use are the principal concern of this report.

The more serious findings in the gastrointestinal tract are gastric retention and adynamic ileus. Suppression of secretion and motility in the stomach may cause retention of food particles, simulating gastric neoplasm. It is possible that toxic amounts of the drug may accumulate in the stomach and either be released into the duodenum in an unpredictable fashion or vomited, thus doing the patient no good, and making evaluation of the dosage schedule difficult. Adynamic ileus is almost certain to ensue if supportive measures are not instituted early and adjusted according to the needs of the individual. The more severe cases may simulate organic obstruction. A simple scout film of the abdomen demonstrates the changes, produced by the drug, frequently before clinical manifestations develop. With constant attention to and control of untoward reactions in the gastrointestinal tract and other body systems, the continued application of this useful adjunctive drug in the treatment of hypertension is justified.

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SUMMARIO IN INTERLINGUA

**Constatationes Roentgenologic in le Vias Gastrointestinal in Consequentia de Effectos Adverse de Hexamethonium**

Hexamethonium se usa hodie plus extensemente in le tractamento de patientes hypertensive que in le passato. Illo es un potente agente de blocage autonome, e le hasardos implicite in su uso debe esser considerate constantemente. Le satis frappante e facilemente demonstrate complicationes gastrointestinal occurrente in su uso es le thema principal del presente reporto.

Le plus serie constatationes in le vias gastrointestinal es retention gastric e ileo adynamic. Le suppression del secretion e del motilitate del stomacho pote resultar in le retention de particulas de alimento, simulante le apparentia de neoplasma gastric. Il es possibile que nivellos toxic del droga se accumula in le stomacho e es alora o liberate in un maniera inpredicibile a in le duodeno o abferite per vomito. Ileo adynamic es un sequella quasi certe si mesuras supportative non es instituite a bon tempore e es regulate secundo le requirimentos del patiente. Le plus severe casos pote simular obstruction organic. Un simple roentgenogramma exploratori del abdomine demonstra frequentemente le alterationes producite per hexamethonium ante le disveloppamento de manifestationes clinic. Providite que le reactiones adverse in le vias gastrointestinal e in altere systemas del corpore es constantemente observate e regulate, le application continue de iste utile droga auxiliar in le tractamento de hypertension es justificate.

# Congenital Malformation of the Renal Artery, a Cause of Hypertension[1]

FRANK ISAAC, M.D., THOMAS H. BREM, M.D., EUGENE TEMKIN, M.D., and HERBERT J. MOVIUS, M.D.

THE CAUSAL relationship of renal pathology to arterial hypertension is not yet clearly defined. The classic experiments of Goldblatt (10) convincingly demonstrated that interference with the renal arterial blood flow through one or both kidneys in the experimental animal can result in sustained hypertension. Goldblatt (11, 12) presents formidable evidence to show that such experimental hypertension bears a striking similarity to essential hypertension in man and suggests that the mechanisms in the two may be identical.

There is, however, a large body of opinion which is strongly opposed to this point of view. Indeed, Smith (24), Goldring (13), and Thompson and Smithwick (26) insist that, with the possible exception of pyelonephritic and pyonephrotic atrophy, urologic disease does not increase the incidence of hypertension, nor is renal disease more common in the hypertensive than in the normotensive population.

Be that as it may, there is general agreement that there are at least certain forms of renal disease which definitely represent the exact human counterpart of the experimental renal hypertension of Goldblatt. Such cases are those in which, for one reason or another, there is a marked reduction, but not a complete suppression, of the arterial blood flow through one or both kidneys.

While the actual mechanism is not definitely understood, it is generally assumed that a relatively ischemic kidney elaborates a pressor substance which acts as a humoral hypertensive agent. The occasional cases of unilateral renal disease in which removal of the diseased kidney alleviates or cures the hypertensive state, lend support to this theory.

These cases comprise a very small but nevertheless an important segment of all cases of hypertension in man. The most obvious instances in this category are the lesions which reduce the renal blood flow directly by mechanical narrowing of the lumen of the main renal artery. Such mechanical narrowing may be caused by thrombosis, arteriosclerotic plaques, aneurysm, neoplasm, or congenital anomaly.

Congenital malformation of the renal artery, producing hypertension by the Goldblatt mechanism, is undoubtedly a rare entity. Yet, it probably occurs more often than it is actually found or even suspected. Careful search of the literature reveals a remarkable paucity of reported examples, and none has appeared, as far as we could discover, in the roentgenologic literature. In 1954, Howard *et al.* (17), reporting on 6 hypertensive patients with unilateral renal disease, described a case (Case 3) of a thirty-nine-year-old man from whom a non-functioning left kidney was removed. Pathologic examination of the specimen disclosed that the main renal artery was absent and in its place several small arteries entered the hilus of the kidney.

During the past three years we have encountered 3 cases of hypertensive disease associated with congenital malformation of one or both renal arteries. One of these cases, the third in the series, presented findings very similar to those described by Howard. The diagnosis of vascular anomaly in our case, however, was established preoperatively on abdominal aortography, since by this time we had become alerted to the possibility by 2 previous observations. In our first case, that of a twenty-

[1] From the Departments of Radiology, Medicine, and Surgery, Veterans Administration Hospital, Long Beach, Calif., and University of Southern California School of Medicine, Los Angeles, Calif. Accepted for publication in December 1956.

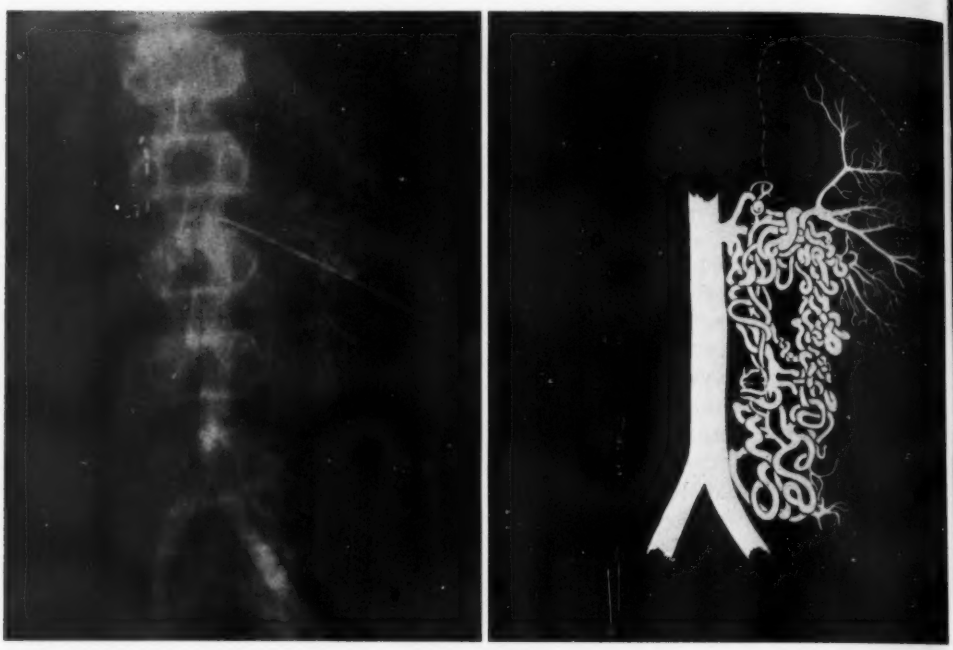

Fig. 1. Case I. Abdominal aortogram, demonstrating cirsoid anomaly of left renal artery. The main trunk of the renal artery is replaced by a tangled group of tortuous vessels. Note that the intrinsic vascular pattern of the kidney is normal. The right kidney has been removed.

Fig. 2. Case I. Pyelographic studies made Oct. 27, 1947, and considered negative at that time. In retrospect, a scalloped, undulating deformity of both ureters is apparent.

five-year-old man with long standing "essential" hypertension, we were not aware of the true situation, despite numerous hospital admissions over a period of six years, until a severe retroperitoneal hemorrhage, necessitating removal of the

right kidney, made us suspect the presence of a dissecting aneurysm. Abdominal aortography then disclosed a malformation of the left renal artery having the appearance of cirsoid angioma. Review of urograms done on the first admission six years previously revealed, in retrospect, distortion of both ureters which, we now believe, is characteristic of such an anomaly (Figs. 2 and 3).

Two years later, this same appearance of one ureter in the urographic studies of another young adult with hypertension aroused our suspicion of a similar vascular anomaly, and abdominal aortography resulted in the discovery of our second case of cirsoid anomaly of the renal artery, this time unilateral.

Because of the rather unusual features they present, these 3 cases will be reported in some detail.

CASE I: R. J. W., a 19-year-old veteran, was first admitted in October 1947, complaining of ringing in the ears, polyuria, and nocturia. Three years previously, during a routine examination, his blood pressure was found to be high. In spite of this, he served in the Army in 1945 and 1946, but received a medical discharge because of hypertension.

The blood pressure on admission was 200/155, the lowest figures with sodium amytal being 160/130. No cardiac enlargement was demonstrable either by physical examination or roentgenologically. Urinalysis, urea clearance, and serology were normal. The Fishberg test showed good concentration, from 1.008 to 1.026. Excretory urograms were not considered remarkable.

The diagnosis of essential hypertension was made, and bilateral thoracolumbar sympathectomy was performed. At the time of surgery, both kidneys were visualized and both adrenals palpated. A renal biopsy showed arterial and arteriolar sclerosis, consistent with hypertensive disease.

For the next five years the patient was followed at frequent intervals both in the Outpatient Clinic and on occasional short readmissions, but no sustained drop in blood pressure developed. He was relatively asymptomatic, except for occasional dizzy spells and palpitation on moderate exertion. During most of this time he was on a salt-free diet and received repeated courses of therapy with various antihypertensive drugs. The systolic pressure over this period fluctuated around 220 mm. Hg and the diastolic around 125.

In March 1953, at the age of twenty-five, the patient was readmitted with symptoms and signs suggesting retrocecal appendicitis. Abdominal exploration disclosed a normal appendix and a large retroperitoneal hematoma in the right upper abdomen, the exact source of which was not established. Following operation, it was obvious that the bleeding, whatever its source, was continuing, as the temperature was irregular and fluctuating, with a daily rise to 102° F; vomiting was frequent, and the hemoglobin was continuously low, varying from 8.5 to 10 gm. Several blood transfusions were given. On re-exploration, one month after the first operation, a large retroperitoneal hematoma was again found, perirenal in location and partially organized. This was removed together with the right kidney. While the source of the bleeding could not be visualized, it was felt at the time of surgery to be the right renal artery.

Fig. 3. Case I. Repeat urogram, May 13, 1953, again showing characteristic contour deformity of ureter.

Pathologic examination of the specimen revealed recent and subacute renal infarctions, arterial and arteriolar sclerosis, recent hemorrhage into the renal parenchyma, and recent organizing pericapsular hemorrhage, with extension into the adrenal, a small fragment of which was removed from the kidney.

Since the actual cause of the bleeding from the right renal artery was still unexplained and the possibility of a dissecting aneurysm was considered, abdominal aortography was performed, May 13, 1953, three weeks after surgery (Fig. 3). This demonstrated an anomaly of the left renal artery, consisting of a large group of tortuous blood vessels, extending from the region of the renal pedicle downward along the course of the ureter to a level just below the bifurcation of the aorta. The main trunk of the renal artery could not be identified in this conglomeration of blood vessels, but an essentially normal vascular pattern was seen within the kidney (Fig. 1).

The patient was discharged on June 2, 1953, much improved, but was readmitted several times during the next two years. His last admission was in October 1955, when the blood pressure was 240/150.

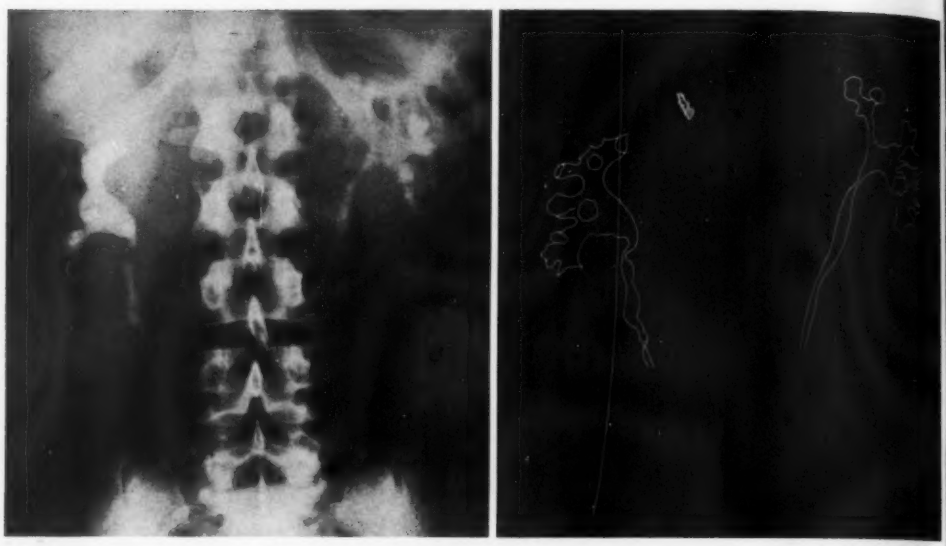

Fig. 4. Case II. Excretory urogram, showing suggestive deformity of right ureter.

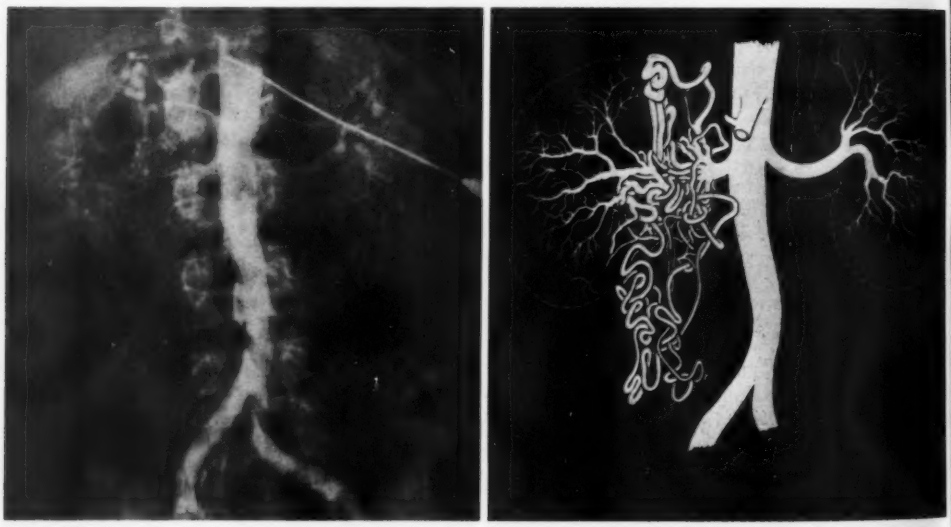

Fig. 5. Case II. Abdominal aortogram, demonstrating vascular malformation of the right renal artery and a normal left renal artery.

*Comment:* This young man was known to have had severe hypertension for nine years before an abdominal aortogram was obtained and the probable cause of the disease was established. It is reasonable to assume that in this instance the delay was of no real consequence, since all available evidence, including the episode of spontaneous retroperitoneal hemorrhage on the right, and careful review of the early urograms point to the strong probability of a bilateral lesion.

Our major reward was that we learned about and became alerted to this form of anomaly of the renal artery as a possible cause of hypertension.

CASE II: E. D. H., a 24-year-old bank clerk, was referred to the hospital by his family physician in April 1955, because of hypertension. His complaints were profuse sweating, inability to relax, and precordial tightness on exertion. His hypertension had been discovered five years previously. In spite of this, he served in the Navy in 1951–1953.

The patient appeared well developed and well nourished and was alert and co-operative. His blood presure was 250/150. Fundal examination showed slight arteriovenous nicking of the retinal vessels. The heart did not appear enlarged on physical examination, but an admission chest film (April 6) and another, two months later, demonstrated moderate left ventricular prominence, with the cardiac transverse diameter at the upper limits of normal. There was a slight increase in the length and density of the aortic arch, consistent with long standing hypertension. An electrocardiogram also showed left ventricular hypertrophy and strain.

Urinalysis, blood count, serological examination, and blood urea nitrogen determination were normal. Regitine and Benodaine, intravenously, produced no significant reduction in blood pressure readings. Sodium amytal test, however, disclosed considerable reduction of both systolic and diastolic pressures under deep sedation (140/116).

Excretory urography, May 9, was interpreted as essentially negative. A few days later, however, in the light of our findings in Case I, a careful review of the films was made. This disclosed a significant irregularity of the contours of the right ureter, suggesting a possible anomaly of the right renal artery (Fig. 4). Abdominal aortography was, therefore, performed on May 19. This demonstrated a vascular malformation having the appearance of a cirsoid angioma, replacing the right renal artery (Fig. 5).

Right nephrectomy was performed July 20, 1955. When the vena cava and the aorta were exposed, the right renal artery was identified and found to be less than 1 cm. in length before it broke up into a large plexus of small vessels, from which several small arteries entered the hilus of the kidney.

The excised kidney was essentially normal both grossly and microscopically. The extrarenal portion of the renal artery was replaced by numerous interlacing vessels of small caliber, several of which were seen to extend into the renal parenchyma. The intrinsic vascular arrangement of the kidney appeared normal.

Perfusion of the renal arteries revealed no arteriovenous communication (Fig. 6). Venous perfusion demonstrated apparently normal venous return.

Immediately following surgery the blood pressure dropped to 130/90. During the next month, however, it gradually rose to as high as 170/115.

The patient was readmitted in January 1956, six months after surgery, for follow-up observation. He stated that he felt very much improved and kept

Fig. 6. Case II. Roentgenogram of the right kidney after removal. The renal arteries which entered at the hilus were perfused with radioopaque material. Note the normal pattern of the intrinsic circulation and the absence of arteriovenous shunts.

at his occupation without interruption. His blood pressure averaged 170 to 180 mm. Hg systolic and 110 to 120 mm. Hg diastolic. In sleep, it was 130/80. A roentgenogram of the chest demonstrated slight, but definite decrease in the size of the heart as compared with the admission film (Fig. 7).

The last admission was in April 1956, nine months after nephrectomy, at which time the blood pressure was 180/110.

*Comment:* It was felt in this instance that we were dealing with a clear-cut case of unilateral renal vascular abnormality, producing a typical "Goldblatt kidney." Nephrectomy, therefore, was believed to be definitely indicated, even though a grossly normal appearing, well functioning kidney was being removed.

The significant reduction of both systolic and diastolic blood pressure readings, maintained, to date, for nine months, appears to justify both the original presumption and the course of treatment adopted.

CASE III: M. B. M., a 41-year-old electronic technician, was first admitted in October 1955, complaining of paroxysmal nocturnal dyspnea of six weeks duration. More recently this had been associated with substernal pain.

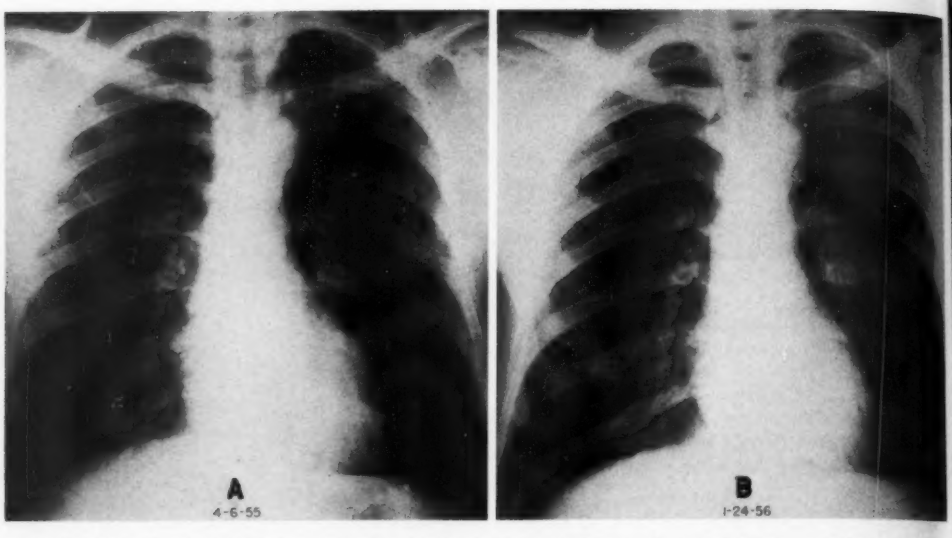


Fig. 7. Case II. A. Admission chest film, showing left ventricular prominence of the heart with the transverse diameter at upper limits of normal. B. Six months after nephrectomy. The heart is noticeably smaller, due to shortening of left ventricular border.

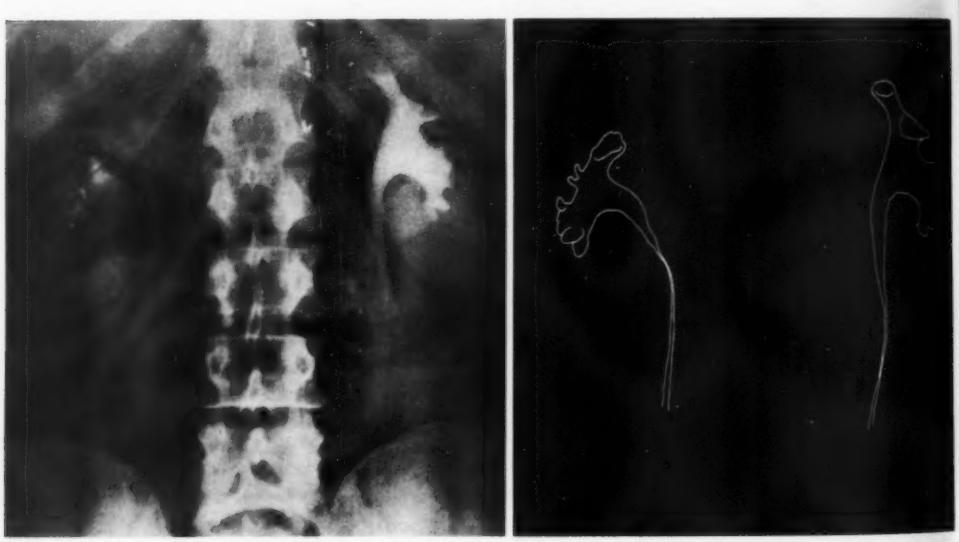

Fig. 8. Case III. Execretory urogram. The right kidney is hypoplastic, but the calyceal morphology is otherwise normal.

The patient was known to have had hypertension since 1948, when a blood pressure of 175/120 was discovered on a routine pre-employment examination. Later, he was studied extensively at another Veterans Administration hospital where eventually, in June 1951, bilateral thoracolumbar sympathectomy was done. This initially reduced the blood pressure to some extent, but within two months the readings were back to the presurgical levels. Treatment with various antihypertensive drugs also proved unsuccessful.

The family history is interesting and perhaps significant, inasmuch as the patient's father suffered from hypertension and died of a cerebral vascular accident. The mother died of diabetic complications.

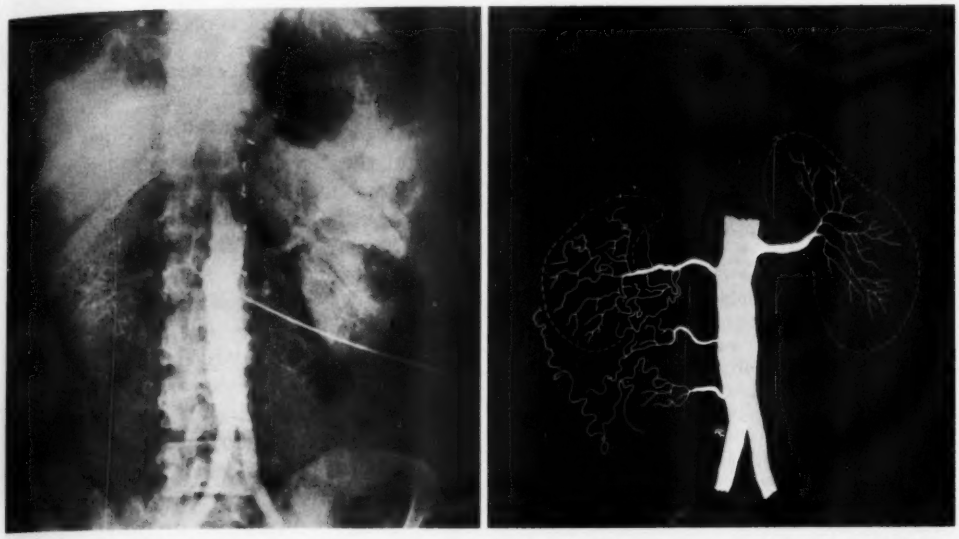

Fig. 9. Case III. Abdominal aortogram demonstrating a single hypoplastic renal artery, supplying the right kidney. The pathological report described several such small vessels entering the hilus of the kidney.

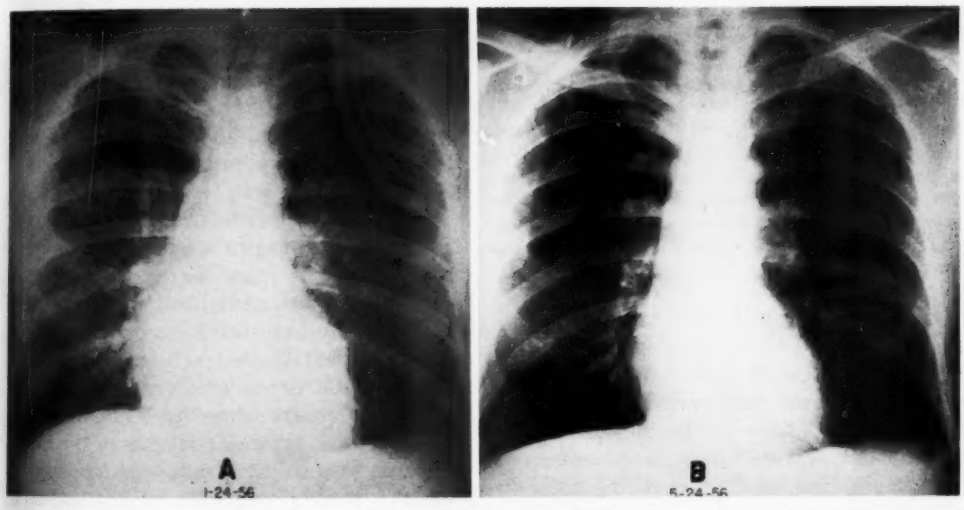


Fig. 10. Case III. A. Chest film showing cardiac enlargement and mild passive congestion of the lungs. B. Two months after nephrectomy. The transverse diameter of the heart was noticeably decreased. The pulmonary congestive changes have largely cleared.

Physical examination revealed nothing remarkable except some arteriovenous nicking of the retinal vessels. The blood pressure ranged between 190/120 and 220/140. A roentgenogram of the chest was essentially negative.

Excretory urography demonstrated a somewhat small but well functioning right kidney with normal morphological characteristics of the collecting structures. The left kidney was entirely normal. Urinalysis showed albumin 2 +, but no other abnormal finding. The blood urea nitrogen was normal.

The patient was given Serpasil, phenobarbital, and Ansolysen, without significant results. Because of the continuing attacks of nightly dyspnea, he was digitalized and eventually discharged, considerably improved, after two months of hospital stay.

He was readmitted about six weeks later, in January 1956, because of continuing attacks of nocturnal

dyspnea. The blood pressure was 204/150, blood urea nitrogen 18 mg. per cent, urea clearance 60 per cent. Urine concentration was 1.005–1.017. A chest film at this time showed left ventricular enlargement and mild passive congestion of the lungs (Fig. 10A).

Excretory urography again demonstrated a small right kidney which was thought to be consistent with congenital hypoplasia. It showed good function both on excretory and retrograde studies, and no distortion of the collecting structures was present to suggest pyelonephritic atrophy (Fig. 8).

Because of the hypoplasia, it was felt that there was a possibility that the artery supplying the right kidney might also be anomalous, and abdominal aortography was performed. The aortogram disclosed a unilateral vascular anomaly on the right, consisting of several small hypoplastic vessels replacing the renal artery. Other small tortuous vessels were present which did not enter the kidney, but a well defined cirsoid angioma could not be identified in this instance (Fig. 9).

On March 23, 1956, right nephrectomy was done. The pathologist's report confirmed the preoperative findings, namely, that the renal artery was replaced by several vessels of small caliber. Sections of the kidney showed thickening and hyalinization of the arterial and arteriolar walls, some of the arterioles being almost completely occluded.

Postoperatively, the patient was kept on antihypertensive drugs. During the first several weeks the blood pressure fluctuated between 160/90 and 190/110. The last check was made Nov. 9, 1956, seven and one-half months after nephrectomy, when the blood pressure reading was 190/100. The patient had gained 12 pounds since the operation, was feeling well, had no nocturnal dyspnea, and was returning to work.

*Comment:* In this case, as in the previous one, we felt that the existence of a unilateral "Goldblatt kidney" was clearly established and nephrectomy was indicated. The follow-up period, as in the previous case, is still short, and one cannot be certain that lasting relief has been obtained, but the presumption is that significant improvement has been achieved by removal of the initiating cause of the hypertensive disease.

## DISCUSSION

Congenital malformation of the renal artery may assume the form of a cirsoid angioma, in which event a tangled group of tortuous vessels gives off several arteries of small caliber to supply the kidney. Or the renal artery may be replaced merely by one or more hypoplastic vessels without a cirsoid anomaly being clearly identifiable. In either event, while the small caliber vessels ramify in a more or less normal fashion within the renal parenchyma, the arterial blood supply reaching the kidney will be significantly diminished, creating a situation analogous to the Goldblatt mechanism.

When the malformation is of the cirsoid variety, the tortuous vessels of the angioma cause multiple indentations on the ureteral walls, giving their contours a somewhat scalloped or undulating appearance, not unlike that of the esophageal rugal folds in the presence of varices.

The condition, therefore, can be suspected on the excretory urogram, provided —as is the case in all medical diagnosis— one is conditioned to think of this possibility. This point should be emphasized because hypertension, *per se*, does not constitute an indication for aortography, whereas in cases of essential hypertension excretory urography is practically always performed. Careful scrutiny of the ureterograms may establish an indication for aortography.

It is not within the scope of this paper to discuss the surgical treatment of hypertension, but it must be realized that in many cases of unilateral renal disease nephrectomy may not be successful unless performed relatively early in the course. This can be explained by the fact that sustained hypertension itself, by continuing increased stress on the walls of the blood vessels, eventually leads to irreversible damage to the arterioles. This, in turn, will tend to perpetuate the hypertensive state even after the original causal mechanism has been removed, be that an adrenal tumor or unilateral kidney disease. Smithwick (25) points out that the three factors which influence peripheral resistance, namely, nervous, humoral and intrinsic vascular disease, may coexist, and that removal of any one of these will reduce the pressure only to the extent that it has itself been operative. This probably ex-

plains the failure to reduce the blood pressure to normal in our 2 patients with unilateral renal disease, although it is believed that significant improvement has been achieved in both cases.

## SUMMARY AND CONCLUSIONS

1. A congenital anomaly of the renal artery is capable of diminishing the blood supply to the kidney, producing hypertension by the Goldblatt mechanism. The incidence of this entity is probably higher than might be inferred from the literature.

2. The malformation may take the form of a cirsoid angioma, giving rise to a characteristic deformity of the ureter by which its presence can be suspected on the excretory urogram. This, in turn, furnishes a clear-cut indication for abdominal aortography, by which the diagnosis can be definitely established.

3. If the disease is unilateral, the condition may be amenable to surgical cure by nephrectomy.

4. It is assumed that the degree of improvement following nephrectomy is inversely proportional to the length of time that hypertension has existed. It is emphasized, therefore, that consideration be given to this possibility at the first discovery of "essential" hypertension, particularly in the young adult.

5. Three cases of renal arterial malformation have been presented, two of which were unilateral. In both of the latter cases significant improvement is believed to have been achieved by nephrectomy.

6. It is hoped that, in the somewhat confused and rather discouraging situation which still surrounds the subject of hypertension, another small step forward has been made, at least as regards an infinitesimal proportion of this important and widespread disease.

NOTE: The authors express their appreciation to Mr. Joseph E. Lovi and Mr. Robert T. Harrison of the Medical Illustration Department for their excellent work in preparing the illustrations for this paper.

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SUMMARIO IN INTERLINGUA

**Malformation Congenite del Arteria Renal Como Cause da Hypertension**

Anormalitates congenite del arteria renal es capace a reducer le provision de sanguine al ren e a producer assi hypertension per le mechanismo de Goldblatt. Le incidentia de iste entitate es probabilemente plus alte que lo que es deducibile ab le litteratura.

Le malformation pote prender le forma de un angioma cirsoide que resulta in un deformitate characteristic del ureter. Le observation de iste deformitate in le urogramma de excretion justifica le suspicion que un angioma es presente. Tal observationes, de lor parte, representa un definite indication pro aortographia abdominal per medio del qual le diagnose pote esser establite conclusivemente.

Si le morbo es unilateral, illo pote provar se curabile chirurgicamente per medio de nephrectomia.

Es stipulate que le grado de melioration resultante de nephrectomia es inversemente proportional al periodo de tempore que le hypertension ha jam existite. Es sublineate, per consequente, le importantia de prender in consideration le facto de iste possibilitate quandocunque hypertension "essential" es primo constatate, specialmente in caso de juvene adultos.

Es presentate tres casos de malformation de arteria renal. Duo de illos es bilateral. In ambe istos, grados significative de melioration pare haber resultate de nephrectomia.

# Dose Distribution in Conical Rotation Therapy with a 2-MEV Generator[1]

W. A. JENNINGS[2] and A. L. McCREA

THE CONCEPT OF conical therapy is far from new. As early as 1906, Kohl suggested a technique in which the x-ray tube revolved about a vertical axis through the lesion to be treated, the beam being appropriately inclined. Later, Knox (1932) extended the method by altering the beam inclination in such a way that two or three annular zones formed the effective point of entry, but this led to the difficulties of a sliding contact in the high-tension supply. This problem Knox solved by setting the tube in an inclined position over the patient; instead of revolving the tube around an axis through the lesion, the patient was rotated about this axis while the tube remained stationary. A similar procedure was described by Henschke (1938). This change not only solves the high-tension supply problem but renders the method more widely applicable, as it can be employed with any existing installation providing the clearance under the tube stand is adequate.

Problems of routine dosimetry appear to have prevented the general use of such a technique, or indeed of any moving-field technique, until after World War II. To confine our attention to conical rotation therapy, the method was next taken up by Green at the Royal Northern Hospital, London, in 1945, where it was developed for the 200–250-kv range for routine use, as described by Green, Jennings, and Bush (1949). Since then, other publications on this subject have appeared, including those by Marquès and Canihac (1950), Quimby, De Castro, and Soifer (1954), and Noriega Limón and Aguilar (1955). Rotating tables designed for such treatments are available from at least three commercial firms in England, and others in the United States, reflecting increased interest in the possibilities of the technique.

In the megavoltage range, 2-MEV Van de Graaff generators have been used for moving-field techniques in which the beam is aimed horizontally at a patient rotating in either a sitting or standing position but, to our knowledge, only one such unit has been adapted to conical therapy. This is at the Royal Cancer Hospital[3] in London. A paper describing both the installation and its use for conical therapy, including dose distributions, was published by Wheatley, Steed, *et al.*, in 1953. The method adopted represents one of two possible approaches. The object of the present discussion is to describe the alternative technique, which has been investigated to ascertain the relative merits of the two methods.

## ALTERNATIVE TECHNIQUES

(A) *Without Surface Cone, Aiming Deep to Lesion Center:* In order to preserve the well known skin-sparing effect due to electronic build-up below the surface, it is necessary to leave the skin free to the air during irradiations, though Lucite plates may be used for beam-directioning purposes in setting up the patient. From Figure 1 (a) it is evident that the use of an inclined beam, rotating about the axis shown, will lead to dose rates which drop rapidly from A to C, partly on account of the increasing distance from the target and partly on account of the reduced tissue path at side A.

Axial dose rates, constant throughout

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The salient points of this study were included in a brief paper delivered by one of us (W. A. J.) during a symposium entitled "Dosimetry in Moving-Field Therapy," at the Eighth International Congress of Radiology in Mexico City, July 1956. Accepted for publication in November 1956.

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[3] Now the Royal Marsden Hospital.

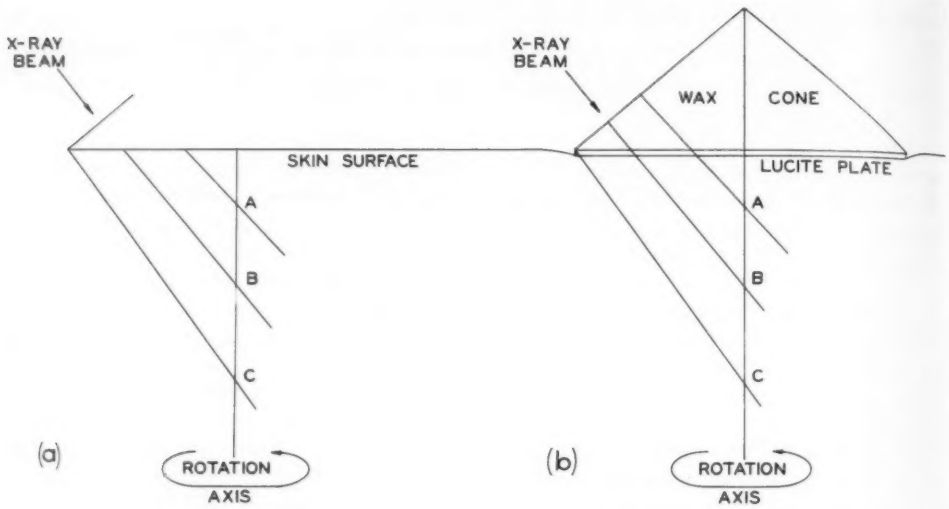


Fig. 1. Principles of conical rotation therapy with and without Lucite plate and wax cone.

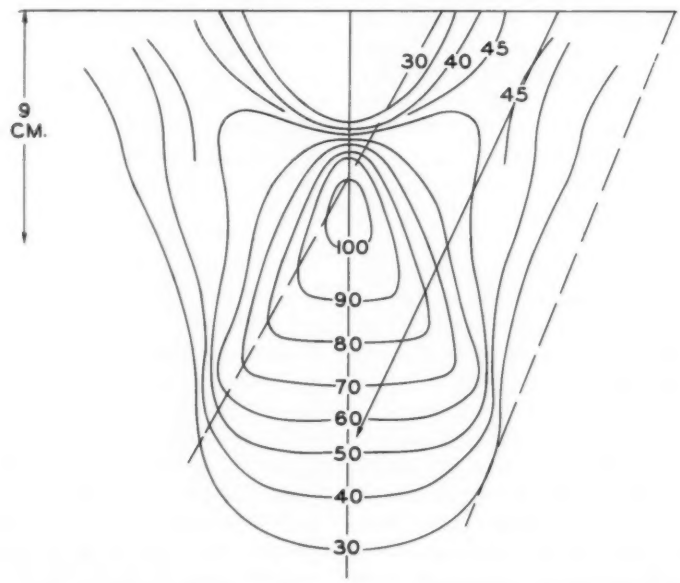


Fig. 2. Dose contours for 360° conical rotation without cone. Field 8 cm. in diameter, at 67 cm. F.S.D., 12.5 cm. rotation radius, 65° tube angle; 2 MEV (Steed, 1953).

rotation, can be derived for an inclined port of entry, and the complete dose distribution for a 360° rotation can be measured or computed. Figure 2, from Steed's (1953) paper, indicates the result for rotation from one side only. Such a distribution could be applied directly to treatment. For example, if suitable, the 80 per cent isodose could be placed around the lesion, with the center point at the edge of the 100 per cent zone (9 cm. deep). Alternatively, if this point is at the mid-

level of a patient 18 cm. thick, two similar rotations could be applied, one from each side, with the summed contours illustrated in Figure 3, also taken from Steed's (1953) paper. This technique entails the use of relatively large fields in relation to the treatment zone. Further, in (iii) isodose charts may be placed directly on a two-dimensional drawing to read off any axial dose rate, as these do not vary during rotation. On the other hand, the skin-sparing effect is lost—the skin level receives depth scatter contributions, and some of the beam is absorbed in the wax.

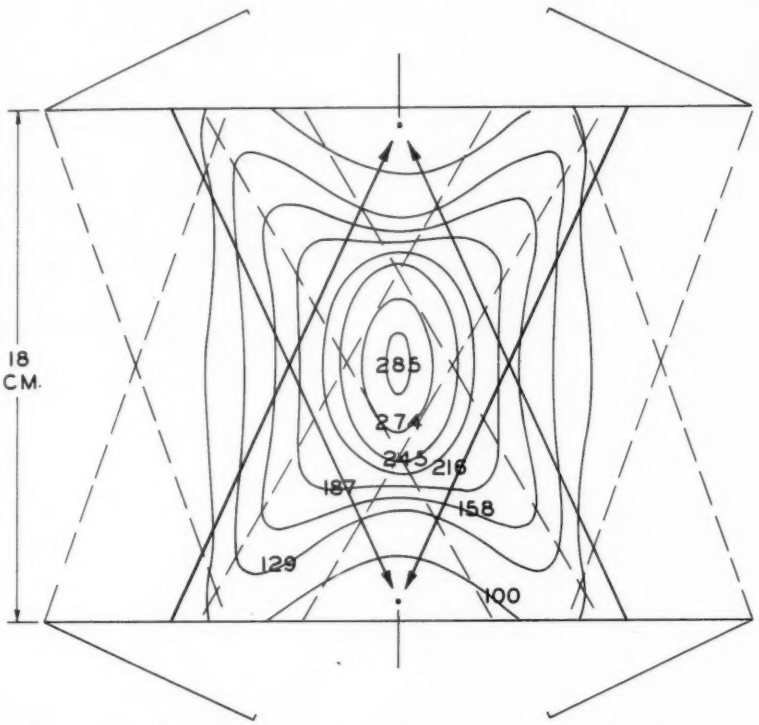


Fig. 3. Summated isodoses for two opposing conical rotations 18 cm. apart, each as shown in Fig. 2. Dose contours at 29 per cent intervals (Steed, 1953).

the case of thin patients, aiming deep to the center of the lesion tends to raise the exit dose, thereby destroying some of the skin-sparing gain previously mentioned.

(B) *With Surface Cone, Aiming at Lesion Center:* The addition of a wax cone, as shown in Figure 1 (b), is seen to solve certain problems, as was first demonstrated by Green, Jennings, and Bush (1949). Thus, (i) it reduces the rate at which the dose level falls from A to C; (ii) it enables one to use a Lucite compressor plate to achieve smaller lesion depths, and a flat surface for accurate dosage calculations; Thus, only if the dose distributions achieved are significantly improved, and the percentage depth doses obtained above are retained or increased, can the change in technique be justified with this quality of radiation.

By adopting an increased rotation radius on the skin (18 cm.), which entails placing bolus at the patient's sides, and using smaller field diameters, it is possible to achieve distributions comparable to those obtained with the previous technique. Figure 4 illustrates the distribution for 360° rotation, the beam axis being aimed at the

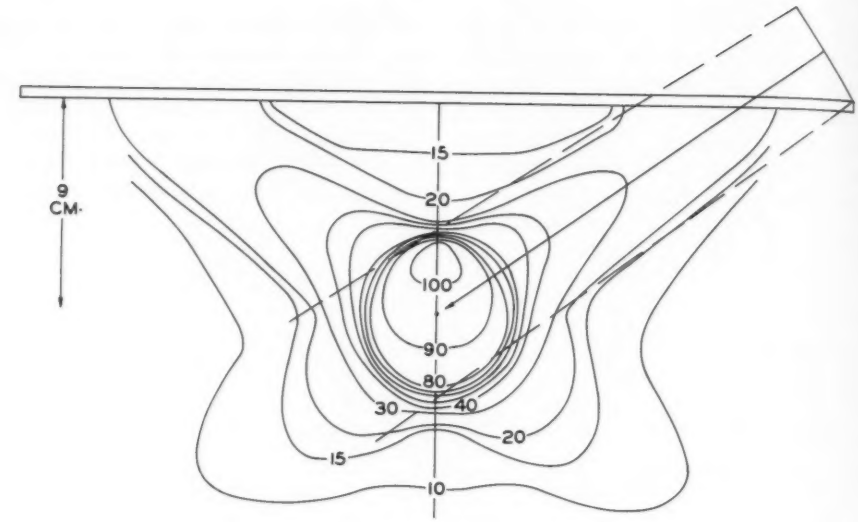


Fig. 4. Dose contours for 360° conical rotation with Lucite plate and cone. Field 5 cm. in diameter, at 100 cm. F.S.D., 18 cm. rotation radius, 34° tube angle; 2 MEV.

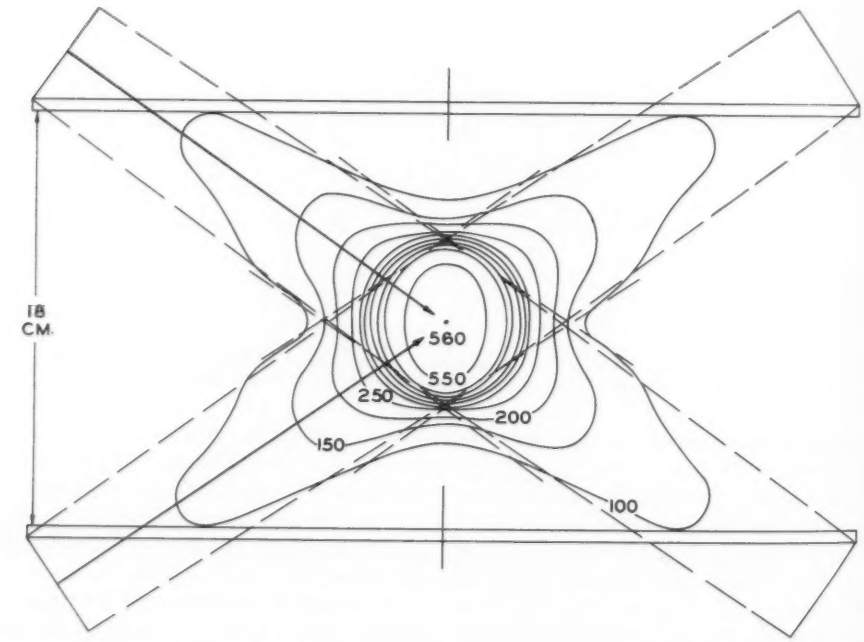


Fig. 5. Summated isodoses for two opposing conical rotations 18 cm. apart, each as shown in Fig. 4. Dose contours at 50 per cent intervals.

lesion center. It will be noted that the 80 per cent isodose is approximately circular and corresponds closely to the beam diameter at the depth in question, which greatly simplifies dosage computation.

These isodoses were measured by film dosimetry, together with check readings obtained from Sievert micro-ionization chambers at selected points both in a phantom and in patients under treatment (in the bladder).

For a patient 18 cm.-thick, as before, two rotation distributions may be summed, producing the combined isodoses shown in Figure 5. In order to compare the distributions achieved by the two approaches in this case, sections taken along the rotation axis, and perpendicular to it, have been read off the curves of Figures 3 and 5 and plotted together in Figure 6. This illus-

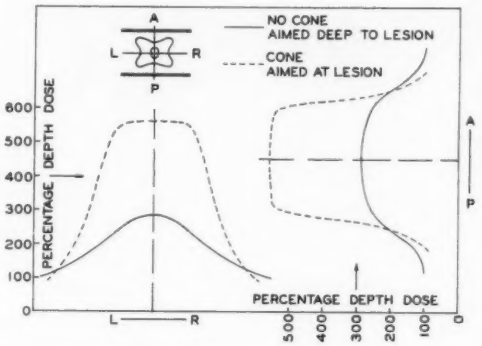


Fig. 6. Dose distributions along the rotation axis, and perpendicular to it, derived from the isodoses of Figs. 3 and 5, to illustrate comparative percentage depth dose variations.

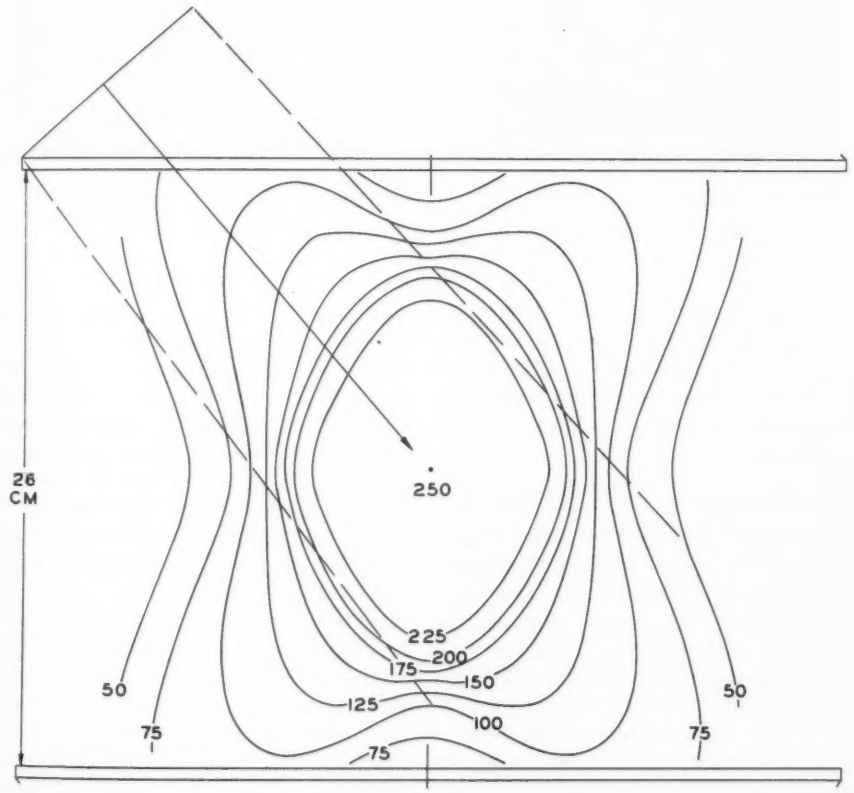


Fig. 7. Summated isodoses for two opposing 360° conical rotations, 26 cm. apart, each with a 10 cm. diameter field at 100 cm. F.S.D., 18 cm. rotation radius, and 50° tube angle; 2 MEV. Dose contours at 25 per cent intervals.

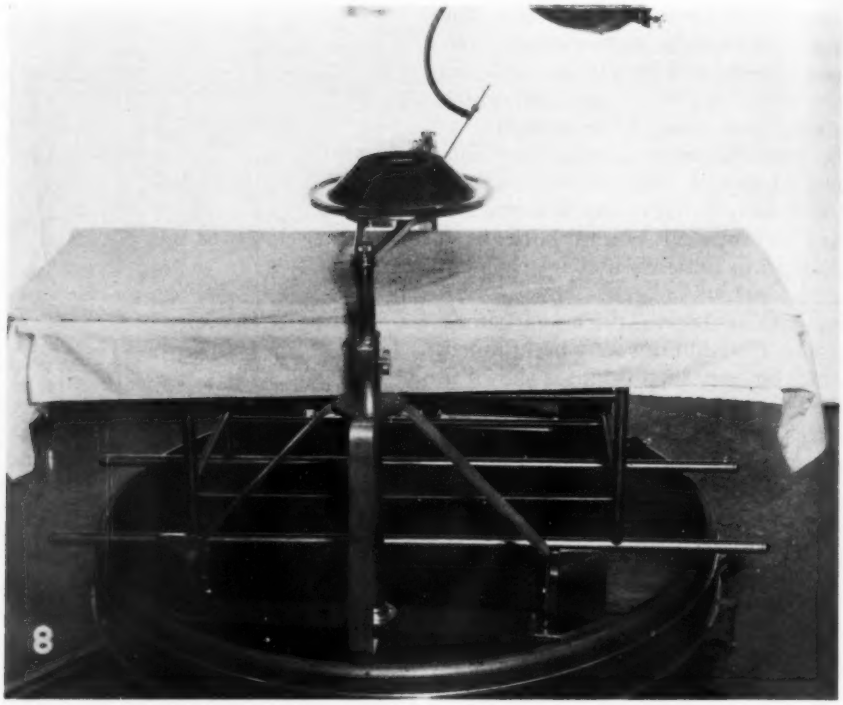

Fig. 8. Photograph of complete rotation equipment, showing the rotation turntable with reversal stop at right, the removable cot, the graduated disc supports with height adjustment, and the wax cone resting on the Lucite disc. The pointer attached to the Van de Graaff generator indicates the F. S. D. setting.

trates both the gain in depth dose and the more rapid fall-off in dosage outside the continuously irradiated volume. The desirability of such a dosage "edge" may be open to dispute, though it is here assumed to be an objective.

### APPLICATION OF THE CONE TECHNIQUE

By the use of larger field diameters, the cone technique can be extended to cover larger volumes. Figure 7 illustrates summed isodoses for a thicker section, the 80 per cent of maximum dose contour again having a width equal to the beam diameter at the depth, though it extends further in the anteroposterior direction.

The technique is effectively limited to near-spherical treatment volumes, though these need not be centrally located. For instance, a bladder center may lie at a depth equal to two-fifths of the patient thickness. For such eccentrically placed lesions, the beam should be aimed at the lesion center from each side, and an equal number of rotations given from each side. The number required must be based on the mean of the two center point dose rates. This results in only small variations in dosage along the axis, and the skin dose is nearly independent of tube angle on account of the compensating factors involved.

The volume, shape, and position of the continuously irradiated zone is determined by three factors: (i) the rotation radius on the surface disc, (ii) the field diameter, and (iii) the tube angle. In the interests of simplicity, we have selected a single rotation radius of 18 cm. and three field diameters of 5.0, 7.5, and 10.0 cm. at 100 cm. F. S. D., the centering depth being varied by varying the tube angle.

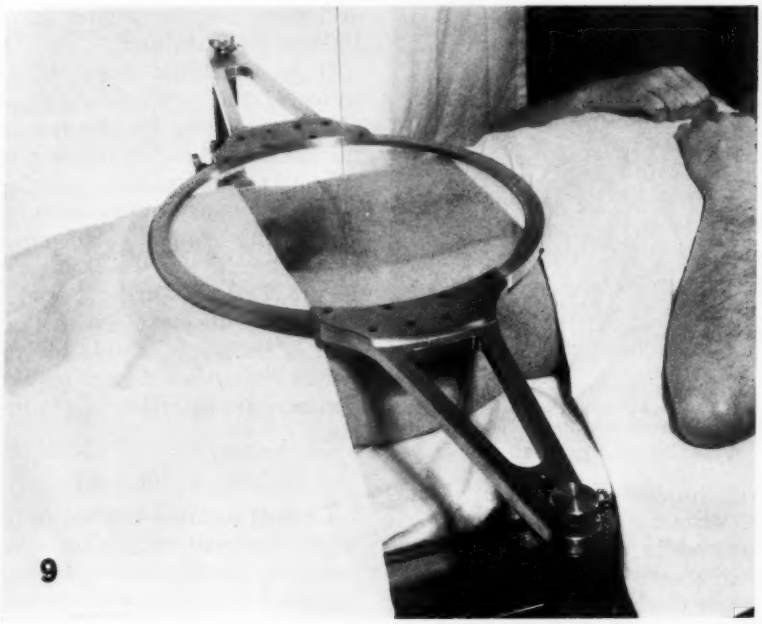


Fig. 9. Photograph showing the Lucite disc with metal rim and the cone-locating pin at the center. The fine rod passing through a central hole is used to assist in setting-up prior to compression.

To a first approximation, one wax cone of average side-inclination will suffice, though further cones with other diameters and inclinations would render the technique more versatile.

Static isodose charts for the three beam widths have been prepared, and laying these on a full-sized drawing of Figure 1 (b) enables one to read off axial dose rates directly, as these do not vary during rotation. Calculation of points off the axis is more difficult, as the dose rate varies during the rotation and, in the case of the skin dose in particular, is rendered inaccurate by the addition of uncertain penumbra and side-scatter contributions. Relevant methods of calculation have been described by Green, Jennings, and Bush (1949) and by Quimby, De Castro, and Soifer (1954). As a general guide, the isodoses of Figures 5 and 7 indicate the shape of the 80 per cent contour in relation to beam width, and the order of percentage depth dose to be expected—running from 250 to 560 per cent, providing the volume is not too close to the skin, when higher percentage contours may reach the surface.

The gain in percentage depth dose achieved by increasing the potential difference of the generator from the 250-kv unit to 2 MEV, together with a change in F. S. D. from 40 to 100 cm., is considerable and is discussed in a separate paper (p. 698). This other paper also compares the percentage dose figures achieved by conical techniques with those for rotating-chair techniques, both at 2 MEV, the beam being aimed horizontally at a sitting or standing patient in the latter method.

## EQUIPMENT DETAILS

With ceiling-mounted units, tube-stand clearance problems do not arise. All that is required is a rotating cot with a disc attachment that can be raised or lowered over the axis of rotation. The rotating platform supplied by the manufacturers of the Van de Graaff equipment is well suited as a basis for this purpose. Figure 8

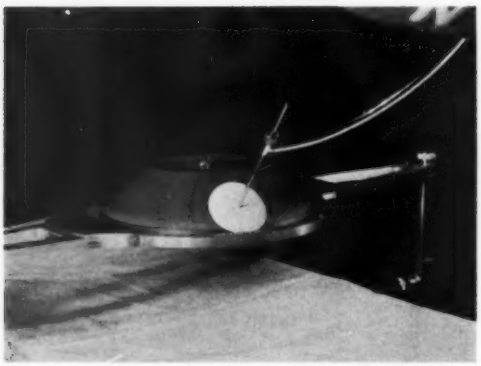

Fig. 10. Photograph illustrating the aiming of the light beam at the edge of the wax cone. (A paper cut-out has been added here in the interests of clarity.)

illustrates the completed equipment. Graduated side supports have been designed and constructed in the hospital machine shop, enabling one to set the disc at a chosen patient thickness, thereby insuring day-to-day repetition of the initial settings.

The disc, with its attached arms, can be removed from the side supports while the patient mounts the cot. The cot itself is of standard design, except that the wheels have been replaced by runners. Adjustment of the disc center over the skin mark indicating the axis of rotation through the lesion is accomplished by first moving the entire cot on its runners, and finally by adjusting the position of the 1-inch-thick sponge-rubber mattress upon which the patient lies, sheets having been added to reduce friction. A thin Lucite rod through a central hole indicates the axis position prior to compression, as shown in Figure 9.

When the compression is correct, and bolus has been added where necessary, the cone (composed of tissue-equivalent material) is placed over the center pin. In order to prevent chipping during handling, the wax has been moulded over a Lucite plate (with Lucite "tongues") prior to turning it to the desired size on a lathe. Aluminum paint was added on the Lucite rim to facilitate aiming the x-ray field with the aid of a light beam, as illustrated in Figure 10, the pointer indicating the 100-cm. focus-distance.

It is sometimes desirable to shield a sector of the complete rotation (*e.g.*, the vulva in bladder treatments), and as the thickness of absorber required is considerable at these qualities, it is better to fit reversing stops to the rotating platform so that, for example, 330° only is covered by the beam. Such a stop can be seen in Figure 8, its position being adjustable. Measurements have shown that a reduction in the angle of rotation to 330° will reduce the surface dose as required without appreciable distortion of the depth distribution.

## SUMMARY

Conical rotation therapy, a technique in which the patient lies on a rotating cot under a fixed inclined beam, was first extended to supervoltage radiations at the Royal Cancer Hospital, London. In order to preserve the skin-sparing effect at this quality, no wax cone was placed in the path of the radiation, and the beam was aimed deep to the lesion center. By this means, the zone of maximum dose can be placed around the lesion from either one- or two-sided irradiations. An alternative approach consists in using a wax cone on the patient surface, so as to reduce the rate of fall in dose level along the rotation axis, the beam being aimed directly at the lesion. The present investigation was undertaken to ascertain the relative merits of these two approaches in terms of dosage distribution, percentage depth dose, and ease of application on a routine footing. The latter technique would appear to offer significant advantages on all three counts.

ACKNOWLEDGMENTS: It is a pleasure to express our appreciation of the interest taken in this technique by Dr. J. W. J. Carpender, Professor of Radiology, and Dr. L. S. Skaggs, Professor of Medical Physics, and for their continued encouragement in developing the method for routine use. In particular, we wish to thank Dr. D. J. Lochman for his interest in the design of the equipment to achieve the dose distributions in practice, and to Mr. J.

Stupka, in whose machine shop the rotating platform was elaborated and adapted to serve the needs of conical therapy.

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## SUMMARIO IN INTERLINGUA

### Distribution del Dosage in Therapia a Rotation Conic con un Generator de 2 MEV

Le therapia a rotation conic—un technica in que le patiente reposa super un lecto rotante sub un fasce inclinate que es fixe—esseva primo extendite a radiationes con voltages superintense al Hospital Royal de Cancere a London. Pro preservar le exemption del pelle a iste qualitate, nulle cono de cera esseva placiate in le via del radiation, e le fasce esseva dirigite profundemente al centro del lesion. Per iste medio, le zona del dose maximal pote esser placiate circa le lesion ab fontes de irradiation uni- o bilateral. Un altere methodo consiste in usar un cono de cera al superficie del patiente, con le objectivo de reducer le nivello del dose de entrata al longo del axe rotational, le fasce essente visate directemente al lesion. Le presente investigation esseva interprendite pro evalutar le meritos relative del duo methodos con respecto al distribution del dosage, al procentage del dose profunde, e al facilitate del application in le practica routinari. Il pare que le secunde del technicas offere avantages significative con respecto a omne le tres factores mentionate.

# Percentage Depth Dose in Moving-Field Therapy

W. ALAN JENNINGS[2]

ONE OF THE PRINCIPAL factors motivating the development of moving-field techniques in radiotherapy has been the achievement of adequate percentage depth doses with increased accuracy and relative ease of setting, compared with multiport approaches. The choice of method for a particular patient depends on a number of factors, such as the size, shape, and site of the lesion; the dimensions and condition of the patient and consequent difficulties in immobilization and setting up the treatment; previous radiation therapy, etc. From the physics standpoint, the dosage distribution and its derivation are of chief concern, and an increasing number of publications have appeared on this subject.

One restricted feature of this problem is the percentage depth dose attainable, and a study of the factors influencing this percentage would appear to serve a useful purpose as a guide prior to the calculation of detailed distributions. The ten sets of curves reproduced here, relating to percentage depth dose, have been computed for homogeneous phantoms to demonstrate (i) the effects of varying certain physical factors for particular techniques, (ii) comparisons between different techniques, and (iii) the advantages of supervoltage over 250-kv qualities in this respect.

## CHOICE OF TECHNIQUES

Two principal techniques were selected for study, one "long-axis" and one "short-axis" rotation. The former is represented by the rotating chair technique, illustrated in Figure 1a, in which the patient rotates continuously (360°) in front of a static x-ray beam. The latter is represented by one form of conical therapy, in which the patient rotates in the horizontal plane under a static inclined beam as shown in Figure 1b, the treatment being delivered from both sides of the patient. The technique here considered includes the use of a "tissue-equivalent" wax cone, whether at 250 kv, as discussed by Green, Jennings, and Bush (1949), or at 2 MEV, as described in the preceding paper by Jennings and McCrea.

In addition, two other techniques are briefly compared. These are conical therapy with wedge filtration, Figure 1c, and 180° arc (or pendulum) therapy, in which the x-ray tube oscillates to and fro over the static patient, as shown in Figure 1d. Both these techniques are considered for treatments from one side of the patient only.

## CHOICE AND RANGES OF VARIABLES

*Radiation Quality:* Both 360° rotation therapy (1a) and conical therapy (without wedge) (1b) have been considered for a deep-therapy quality of 3 mm. Cu half-value layer, and for a 2-MEV Van de Graaff generator. Techniques 1c and 1d are here restricted to the softer range.

*Phantom Dimensions:* For both 360° rotation therapy (1a) and 180° arc therapy (1d), elliptical "patient" sections have been adopted with short and long axes of 16 and 26, 20 and 30, and 24 and 34 cm. For conical techniques (1b and 1c), parallel-sided patient-thicknesses from 14 to 30 cm. are considered.

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The curves of Figures 2, 3, 5, 7, 9, and 11 formed a part of a more general lecture entitled "Relative Merits of Arc, Rotating Chair, and Conical Therapy at 250 kv from the Physics Standpoint," and those of Figures 4, 6, 8, and 10 were included in a symposium on "Dosimetry in Moving Field Therapy," both delivered at the Eighth International Congress of Radiology in Mexico City, July 1956. Accepted for publication in November 1956.

[2] Now at the Royal Northern Hospital, London N.7., England.

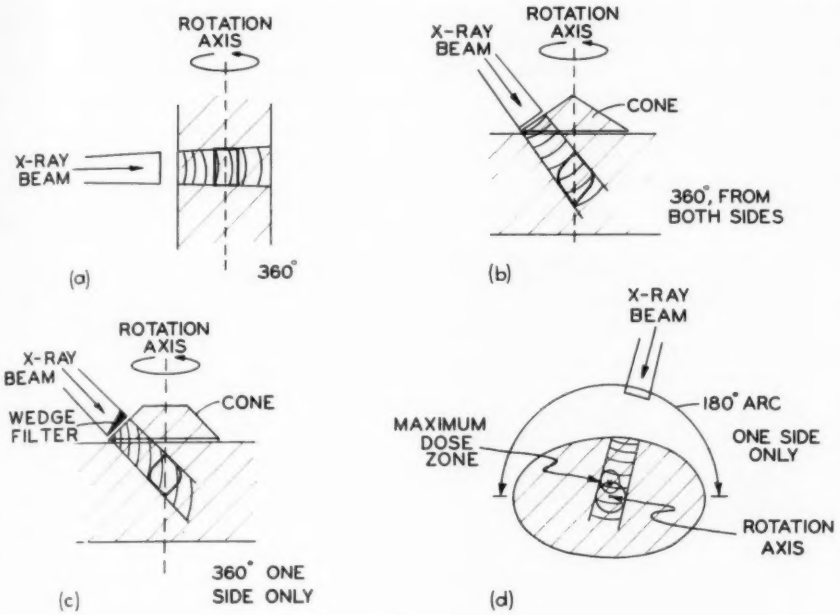


Figure 1

*Other Variables:* Rotation radii were fixed for the various techniques as indicated in Figures 2 to 11, the variable factors being the field size and elongation and the position of the center of the lesion, in addition to patient size and radiation quality.

## METHODS OF COMPUTATION

It is not the intention here to discuss the detailed calculations entailed in deriving the data presented. The percentage depth dose is taken as the ratio of the maximum depth dose to the maximum surface dose, and the calculations required to derive these two dose levels vary with the techniques.

For conical therapy at 3 mm. Cu h.v.l. (1b and 1c), the methods given by Green, Jennings, and Bush (1949) were adopted. For this technique (1b) at 2 MEV, measurements made by Jennings and McCrea (1957) were relied upon and extended by calculation along similar lines.

For 180° and 360° rotation therapy, unpublished graphical data were employed. At 3 mm. Cu h.v.l. (1a and 1d), curves derived by Jennings (for Marconi Instruments, Ltd., England, 1955) were used, and at 2 MEV (1a), curves derived by Trump *et al.* (for High Voltage Research Laboratory, Massachusetts Institute of Technology, 1954).

## PERCENTAGE DEPTH DOSE FOR 360° ROTATION

### (*Figure 1 a*)

(*a*) *Dependence of Percentage Depth Dose (P.D.D.) on Field and Phantom Size for Central Axes:* For radiation of 3 mm. Cu h.v.l., and with a rotation radius (target-to-axis distance) of 60 cm., the curves of Figure 2 indicate the dependence of P.D.D. on field area (at the axis) for three phantom sizes. These curves relate to mid-line axes and unit field elongation (square or circle).

In order to appreciate the curve shapes, it may be well to recall the factors influencing the surface and axial dose rates under rotation for a particular radiation quality. It is usual to consider the con-

ditions holding at each of a series of positions at equal angular intervals, and thence to derive the mean axial dose rate and the point of maximum dose per rotation on the surface. These data suffice for P.D.D. data for 360° central-axis rotations, though off-axis points are necessary for distribution studies and for

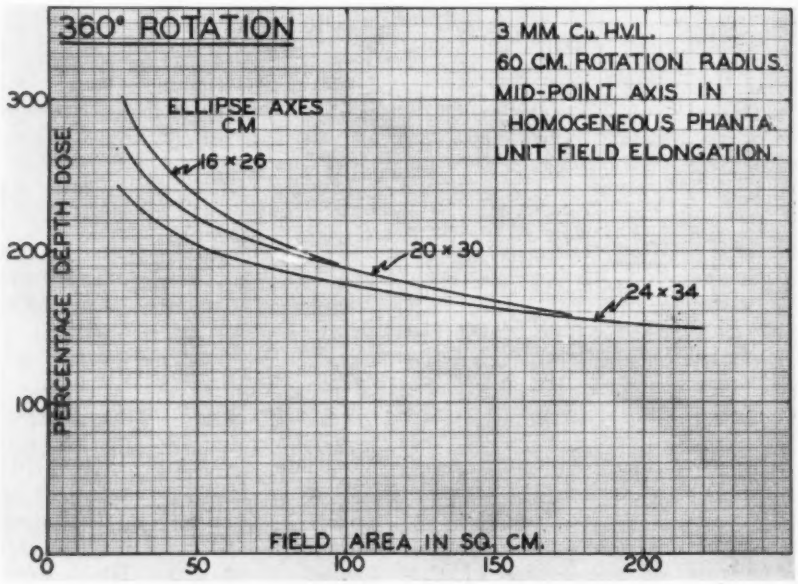


Figure 2

maximum depth-dose points in non-symmetrical set-ups, such as 180° arc therapy.

The series of static depth-dose contributions at intervals around the section will depend on the changing F.S.D. and phantom depth. Further, the surface field size will vary, affecting both the surface-dose rate and P.D.D. factors. The dose received during a rotation at a particular point on the surface, however, depends not only on the varying surface-dose rate, but also on the fraction of the total time that the point remains in the beam. In addition, this calculation has to allow for penumbra, side-scatter, and exit-dose contributions.

The increase in the P.D.D. with decrease in field area under rotation (Fig. 2) is due to the greater reduction in the surface dose resulting from the reduced fractional time of irradiation as against the smaller reduction in depth dose for smaller fields. The more rapid fall in P.D.D. with increase in field size for the smaller phantom sizes is chiefly due to the larger exit-dose contributions.

(*b*) *Dependence of P.D.D. on Field Size and Shape, and on Axis Position:* For a single (average) phantom size of 20 × 30 cm., and for the same radiation quality and radius of rotation as above, the curves of Figure 3 indicate the effect of displacing the axis of rotation from the central position and of using rectangular fields with the long axis parallel to the axis of rotation. Thus, for a given field area, the employment of elongated fields increases the P.D.D. significantly. This results from the gain in depth dose with field size in relation to the reduced fractional time spent in the beam by surface points traversing the narrow field dimension.

On the other hand, displacement of the rotation axis to two-fifths or three-quarters of the section's 20-cm. thickness is

seen to lead to a drop in P.D.D. for a given field area. This is chiefly due to the definition of the P.D.D. in terms of maximum surface dose, for this maximum is reached at the surface point closest to the axis and hence rises as the axis is displaced from the mid-line (see also sketch on Fig. 9).

certain relation to skin reaction, it may be wise to base the P.D.D. data on the figure at that depth rather than at the surface. This change lowers the curve to about one-half (*i.e.*, the second curve down), and it is this curve which should be compared with the 5 × 5-cm. field curve for the softer radiation quality (Fig. 4).

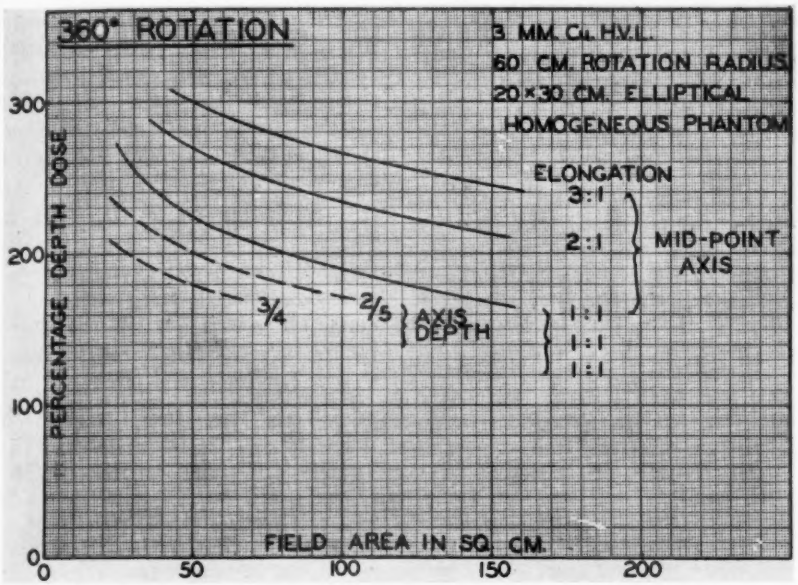


Figure 3

(*c*) *Dependence of P.D.D. on Phantom Size at Two Radiation Qualities and Field Sizes, for Central Lesions:* With field sizes of 5 × 5 and 10 × 10 cm. (at the axis), the curves of Figure 4 were computed to illustrate the gain in P.D.D. achieved by changing from a radiation quality of 3 mm. Cu to 12.6 mm. Cu h.v.l., the latter referring to a 2-MEV (constant potential) generator. Increased tube output also makes it possible to increase the radius of rotation from 60 to 125 cm. when a Van de Graaff unit is used. Calculated from Trump's data, the upper curve (in Fig. 4) relates to the actual surface dose rate for a 5 × 5-cm. field. Due to electron build-up, however, the level of maximum dose for a static beam occurs at a depth of 4 mm. and, in view of the un-

The three corresponding curves for a 10 × 10-cm. field are also included in the graph, and it will be noted that the gain in P.D.D. due to increase in radiation quality is greater for small fields. Also, it increases more rapidly with increasing phantom size for small fields.

## PERCENTAGE DEPTH DOSE FOR 2-SIDED CONICAL ROTATION

### (*Figure 1b*)

(*a*) *Dependence of P.D.D. on Phantom Thickness and Centering Depth for Two Field Sizes:* The curves of Figures 5 and 6 relate to conical rotation carried out with a suitable wax cone.

Figure 5 relates to radiations of 3 mm. Cu h.v.l. only, with a 40-cm. target-to-cone-surface distance. With the aperture

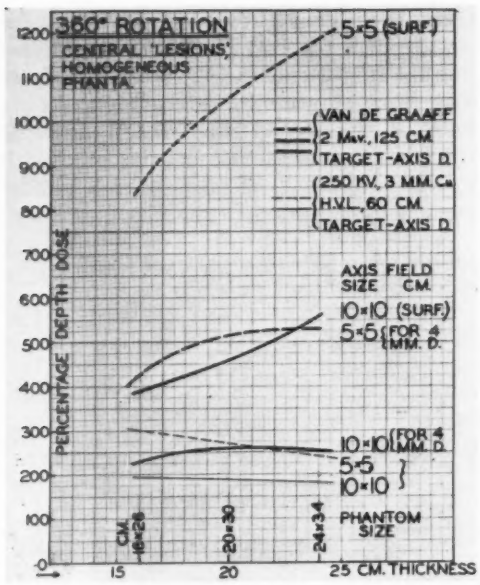


Figure 4

ness for two-sided conical rotation, aimed at the mid-point from each side, for two field sizes. The dotted lines demonstrate the effect of changing the centering depth, the beam being aimed at the same point from each side. It will be noted that, in general, non-central locations lead to an increase in P.D.D. for a given phantom thickness in this technique, in contrast to the reduction resulting from the corresponding axial displacement in 360° (short-axis) rotation (type 1a), as shown in Figure 3.

It must be pointed out, however, that this increase in P.D.D. in the conical irradiation of eccentrically located lesions can be achieved only when an equal number of rotations are given from each side. Under these circumstances, the two different beam inclinations will lead to a certain variation of dosage along the rotation axis within the continuously irradiated volume. The extent of this variation can readily be derived by laying the appropriate static isodose chart on a full-scale drawing of the set-up, as the dose rates at points along the axis do not vary

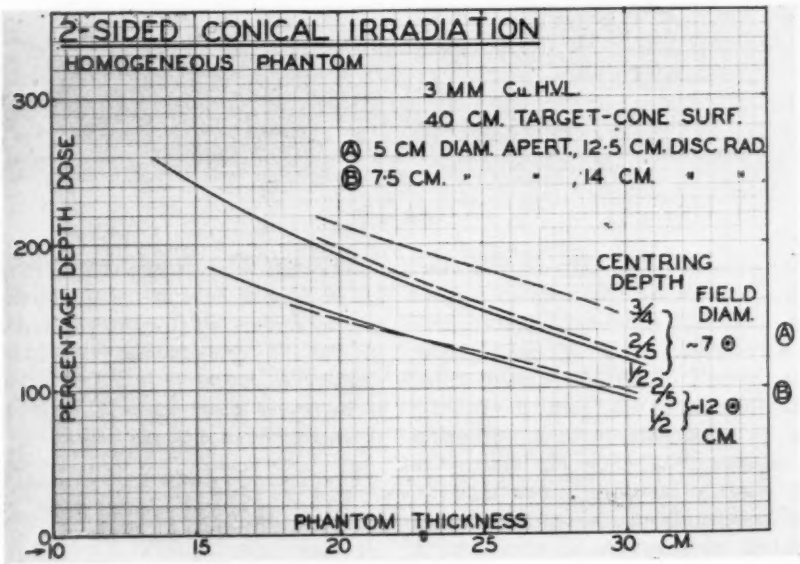


Figure 5

sizes and disc radii adopted, effective field diameters of approximately 7 and 12 cm. are achieved at the axis of rotation. The full lines indicate the fall in P.D.D. with increasing phantom thick-

during rotation. If considered significant, the variation in dosage can be reduced by applying two "deep" to one "shallow," or three "deep" to two "shallow," rotations, though such a change leads to differing skin doses on the two sides, and to a drop in P.D.D. The actual maximum skin dose per rotation is found to be nearly independent of the beam angle (for a given disc radius). In practice, a compromise between P.D.D. and the measure of uniformity in lesion dosage may be chosen, though the use of partially compensating wedge filters may resolve the problem of uniformity without loss in P.D.D.

(*b*) *Dependence of P.D.D. on Phantom Thickness at Two Radiation Qualities and Field Sizes, for Central Lesions:* The two full curves of Figure 5, here adapted to effective field diameters of 6 and 12 cm., are reproduced in Figure 6 in order to compare them with the corresponding curves for a similar technique at 2 MEV, the target-to-cone-surface distance and disc radii being also increased at the latter quality, as indicated on the figure.

For the smaller field diameter, the change in quality leads to a twofold increase in P.D.D. for small phantom thicknesses, rising to a threefold increase for greater depths. On the other hand, the gain in P.D.D. for the larger field is less significant, chiefly on account of the increased overlapping exit-dose contributions for two-sided treatments at 2 MEV, particularly at small phantom thicknesses.

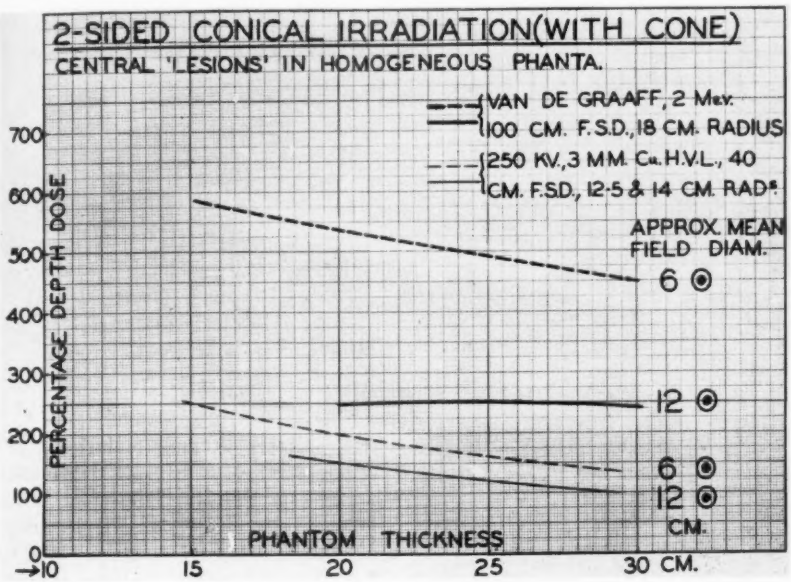


Figure 6

As in the case of 3 mm. Cu h.v.l. radiations, the maximum P.D.D. achieved for eccentrically located lesions entails the use of an equal number of rotations aimed at the same point from each side. On the other hand, for the 2-MEV set-up conditions, the resulting variation in dose rate along the rotation axis is negligible and the P.D.D. is maintained, though not increased, by non-central settings.

### COMPARISON OF P.D.D. IN 360° ROTATION AND 2-SIDED CONICAL IRRADIATION

(*a*) *For Central Lesions, at 3 mm. Cu h.v.l.:* The curves of Figure 7 indicate the dependence of P.D.D. on phantom size

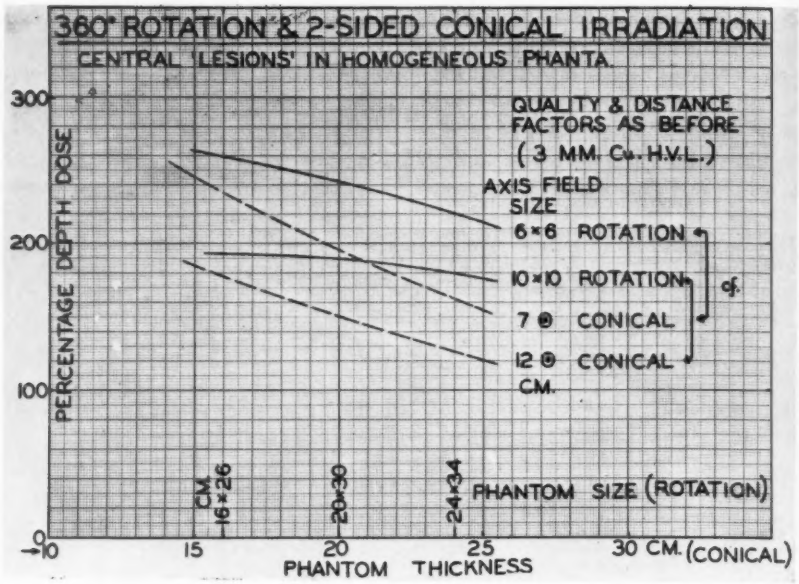


Figure 7

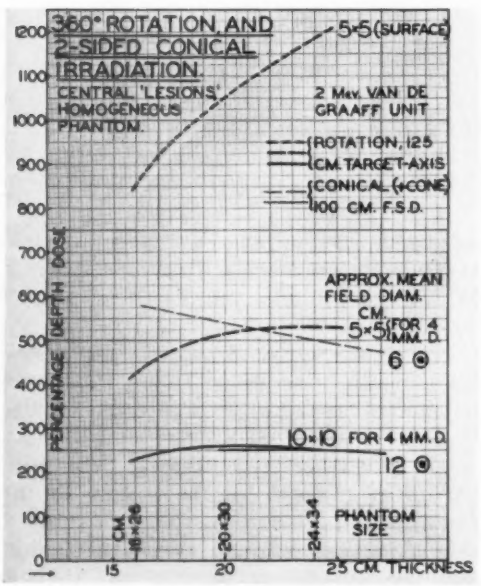


Figure 8

for two field sizes aimed at the mid-point for the two techniques. Square fields of 6 × 6 and 10 × 10 cm. are taken as equivalent in area to circles of 7 and 12 cm. diameter respectively for comparison purposes. It will be seen that the alternative approaches offer similar percentage depth doses for small phantom thicknesses, whereas the 360° rotation provides significant advantages over the conical method as the thickness increases. The more rapid fall in the curves for conical therapy is due to the oblique entry of the beam as compared with the near-perpendicular entry in the alternative technique. The consequences of this difference will be more apparent in section (*c*) below.

(*b*) *For Central Lesions, at 12.6 mm. Cu h.v.l.:* The curves of Figure 8 correspond to those of Figure 7 at the softer quality if one ignores the upper curve, based on the actual surface-dose data, and uses instead that based on the 4-mm. depth dose, as previously discussed. For purposes of comparison, square fields of 5 × 5 and 10 × 10 cm. are taken as equivalent in area to circles of 6 and 12 cm. diameter, respectively, and attention should be drawn to the different F.S.D. settings adopted in the two techniques.

At this quality, the two techniques offer very similar percentage depth doses at the greater phantom thicknesses, whereas

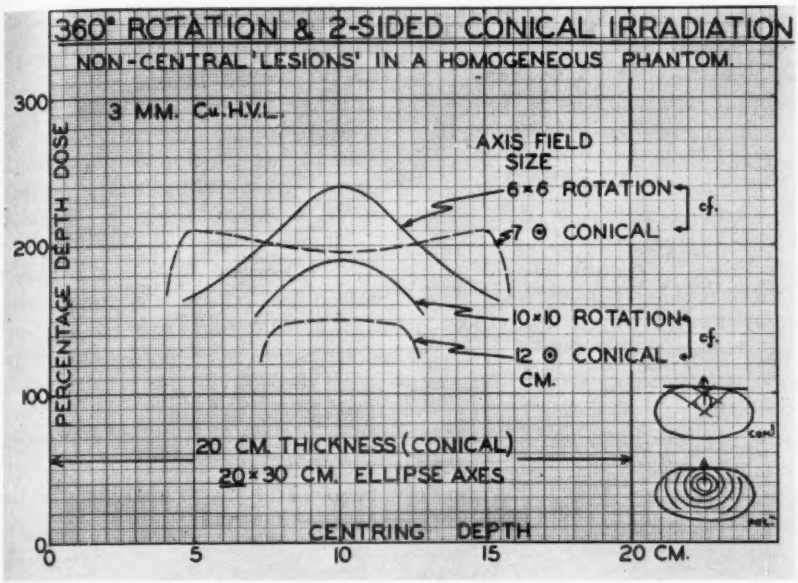


Figure 9

the conical approach is more advantageous for the lesser depths. This divergence is due to the reduced exit-dose contributions resulting from the oblique entry of the beam—a factor of less significance at the softer quality. The larger field size cannot be applied by the conical technique to the thinner sections on account of surface overlap, leaving no choice for such cases.

(*c*) *For Non-Central Lesions, at 3 mm. Cu h.v.l.:* With a single phantom size of 20 × 30 cm., the curves of Figure 9 indicate the dependence of P.D.D. on centering depth for corresponding field sizes for the two techniques. Thus, the P.D.D. figures for a depth of 10 cm. correspond to those of Figure 7 for a 20 × 30-cm. phantom, whereas the remainder of the curves demonstrate the change in P.D.D. as the centering depth approaches either surface. The full curves of Figure 9, derived from those of Figure 3, show the effect of displacing the axis in 360° rotation, the P.D.D. dropping as the surface dose per rotation increases at the point closest to the axis, as illustrated in the small sketch on the figure. On the other hand, from

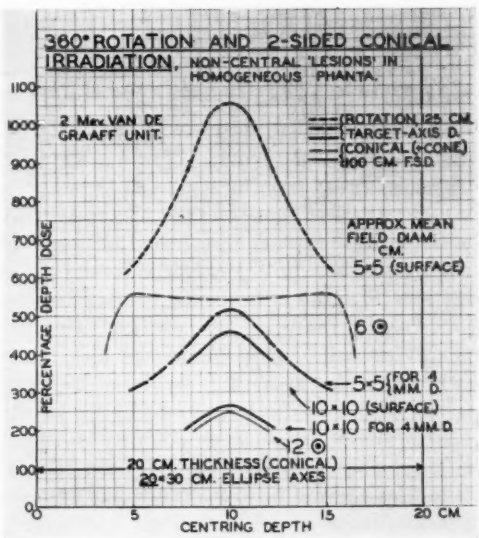


Figure 10

the curves of Figure 5, the P.D.D. for eccentrically located lesions irradiated by small fields in the conical technique is seen to rise as the surface is approached, as illustrated by the dotted lines in Figure 9; this rise ceases when the contin-

uously irradiated volume is close to the surface (see sketch).

The oblique entry of the beam in conical therapy is seen to be an asset for shallow depths, the curves giving magnitude to a principle which may be self-evident.

(*d*) *For Non-Central Lesions, at 12.6 mm. Cu h.v.l.:* The curves of Figure 10 correspond to those for Figure 9 at the softer quality. As before, the P.D.D. based on the actual surface-dose data are included for completeness, but again the comparison is best made with the 4-mm. depth-dose data.

The 10 cm. centering depth figures correspond to those of Figure 8 for a 20 × 30-cm. phantom, and the remainder of the curves demonstrate the change in P.D.D. as the centering depth approaches either surface. The pattern is essentially similar to that discussed in section (*c*) above.

### PERCENTAGE DEPTH DOSE FOR 180° ARC (FIG. 1*d*) AND ONE-SIDED CONICAL (WEDGE) IRRADIATION (*Fig. 1c*)

Both these techniques relate to irradiation from one surface only, and thus warrant direct comparison.

Let us first consider conical therapy with wedge filtration. As illustrated in Figure 1c, the purpose of the wedge is to incline the dose contours so that they run parallel to the axis of rotation, thereby achieving uniformity of dosage along this axis without opposing fields. The distribution throughout the remainder of the continuously irradiated volume is found to approach uniformity, and thus form a suitable technique for relatively superficially located lesions where contributions from the far side would be small and uneven. The dotted lines in Figure 11 indicate the percentage-depth-dose factors which can be expected at 3 mm. Cu h.v.l., with a similar set-up to that for two-sided irradiations without a wedge filter. It is clear that the technique is well suited to the use of small fields and relatively shallow treatment depths, though it is limited to these if 100 per cent depth dose is to be exceeded, unless more fields are added elsewhere.

With 180° arc therapy at the same radiation quality, and with the 60-cm. rotation radius previously considered, P.D.D. curves are provided which do not drop as rapidly with increasing phantom depth, as shown in the full-line curves in Figure 11. However, a careful distinction between the axial depth and maximum dosage depth, and between the mean axial dose rate and mean maximum dose rate, must be drawn, as illustrated in Figure 1d. Such a displacement is self-evident from the unsymmetrical arrangement, and it is necessary to place the axis of rotation deep to the lesion center if the maximum-dose zone is to coincide with the lesion. This divergence is included in the curves of Figure 11, the thin, full lines indicating the P.D.D. at the rotation axis position, and the thick, full lines indicating the maximum P.D.D. data. The "axis" curves relate directly to the centering depth, whereas the "maximum" curves are appropriately displaced towards the surface.

### NON-HOMOGENEOUS PHANTOMS

Although the present study has been confined to homogeneous phantoms, it is pertinent to include a brief reference to the effects of inhomogeneities. Preliminary measurements indicate very significant factors for lung and bone effects, particularly at the softer quality under discussion. Thus, for 360° rotation (Fig. 1a), correction factors of 30 per cent or more to the P.D.D. achieved arise at 3 mm. Cu h.v.l., though these may be halved in using the 2-MEV unit.

### SUMMARY

Although full dosage distributions are necessary for comparison of the relative merits of differing moving-field techniques with one another, or with multiport approaches, the *percentage depth dose* attainable in each case is a significant feature, and a study of the factors influencing this percentage may well serve as a useful guide

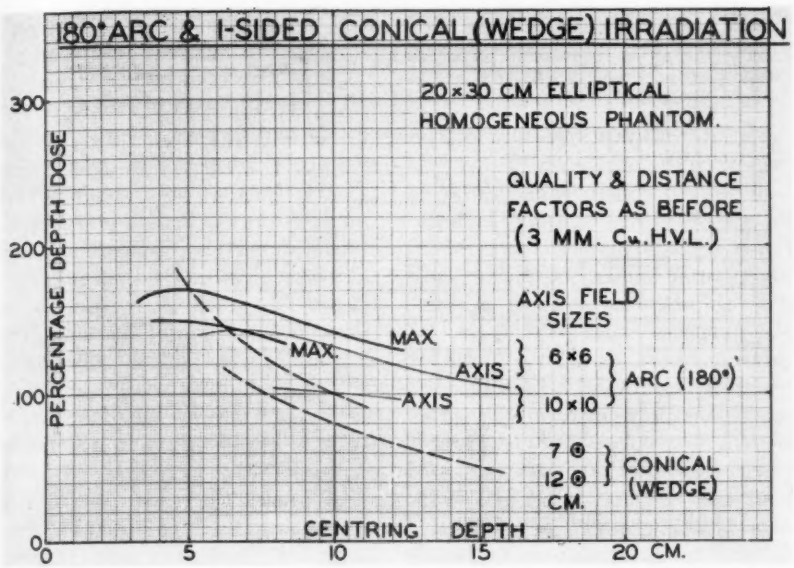


Figure 11

prior to more extended calculations. With this object in mind, ten sets of curves relating to percentage depth dose have been computed for homogeneous phantoms. These demonstrate (i) the effects of varying certain physical factors for particular techniques, (ii) comparisons between different techniques, and (iii) the advantages of supervoltage over 250-kv qualities in this respect. The techniques include both "short-axis" and "long-axis" rotation methods in current use.

ACKNOWLEDGMENTS: It is a pleasure to record my thanks to Miss Alice McCrea for her help in computing some of the data relevant to the 2-MEV percentage depth dose curves under selected conditions.

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## SUMMARIO IN INTERLINGUA

### Procentage de Dose Profunde in Therapia a Campo Mobile

Ben que complete distributiones de dosage es necessari in le comparation del meritos de un technica a campo mobile con illos de un altere o con le meritos de un technica a orificios multiple, le *procentage del dose profunde* que es attingibile in le varie casos es un puncto importante, e un studio del factores que influentia iste procentage pote ben esser de valor como guida ante le execution de plus extense calculationes. Con iste objectivo, dece gruppos de curvas relative al procentage del dose profunde esseva computate pro mannequins homogenee. Illos demonstra (i) le effectos del variation de certe factores physic secundo le varie technicas, (ii) comparationes inter differente technicas, e (iii) le avantages de voltage superintense ante qualitates a 250 kV in iste respecto. Le technicas examinate include methodes a rotation del "axe curte" e a rotation del "axe longe" que es in uso currente.

# The Use of Electron Beams in Industrial Processes[1]

E. DALE TROUT, B.S., D.Sc.

THE USE OF HIGH-ENERGY electron beams in industrial processing has been the subject of considerable publicity in the last two or three years. Radiologists are always interested in the application of any type of ionizing radiation and, since the development of x-ray equipment for medical purposes often reflects the design of equipment for industrial uses, it seems logical to assume that radiologists as a group have been interested in this development. The purpose of the present paper is to review some of the history of non-medical uses of electron beams, to indicate some of the current industrial applications, and to point out some future possibilities.

In most devices electrons are contained within the device itself. Electron-beam sources are different in that the electrons are brought out of the device or generating source. Like most technical developments, the use of electron beams is not new. Prior to the last few years, however, they were limited to scientific studies rather than to any large-scale practical application.

Lenard, in 1894, described a tube from which it was possible to bring out the electrons through an aluminum foil window. Although his tube operated at low voltages, the air in front of the window showed luminosity for a distance of 5 cm. Fluorescent materials became luminescent at distances as great as 6 to 8 cm. from the window.

Des Coudres devised a cathode-ray tube in 1897 and tubes of this type were described by Pauli in 1910 and again in 1920. In 1925 Kruger and Utesch published an account of a hot cathode, high-vacuum tube for producing an external beam.

All these early tubes probably worked at less than 100 kv. In 1926, Coolidge described a tube for operation at voltages up to 250,000 volts. With this he studied the possible changes in the color of diamonds, the changes in fused quartz and sodium chloride crystals, changes in electrical insulators, electron radiographs of delicate tissues, chemical effects on aqueous solutions, the action on bacteria, plant, and animal tissues, and the doses required to destroy fruit flies, snails, and cockroaches. Tissue effects were also studied in a long series of experiments in which small areas of rabbits' ears were exposed.

At about the time that Coolidge was conducting his experiments, Brasch and Lange in Germany were seeking a very high-voltage source for atomic research. They strung a long antenna between two peaks on Mt. Genoroso, in that region of the Alps where thunderstorms and lightning discharges were common, and were able to obtain and measure short time impulses as high as 20,000,000 volts. They then returned to Berlin and set out to develop an electron tube for use in their atomic studies. Before this could be finished, however, Cockcroft and Walton in 1932 completed their work and "smashed the atom," using 200,000-volt protons. Brasch and Lange then turned their attention to the development of a 3,000,000-volt impulse generator and electron tube and became interested in the possibility of sterilizing food with their apparatus. In 1933 Hitler came to power, and in 1935 Brasch went to the Netherlands. He spent the next two or three years in England, the United States, and France, and in 1938 was back in New York, where he interested an influential group in the possibilities of food sterilization with electrons. An organization called Electronized Chemicals was set up, and in 1944 an old ice storage plant in Brooklyn was leased and construction was

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started on a large impulse generator and tube. The equipment was put into operation in early 1946, and Brasch with the assistance of an old acquaintance, Dr. Wolfgang Huber, set out on a food sterilization program. Their apparatus was said to operate at 4.5 MEV and tube currents of 10,000 to 15,000 amperes for pulses of about 1 microsecond. They reported success in sterilization of foods, but encountered taste problems and other difficulties. The short exposure times stressed by these workers, and the long charging periods required by the impulse generator, held little promise for any practical application where quantities of material must be handled continuously.

In the meantime, Proctor, Goldblith, and their associates in the Food Technology Department at the Massachusetts Institute of Technology were experimenting with a Van de Graaff generator with continuous low-intensity exposures. They were able to duplicate Brasch and Huber's results and found that the end-result is a function of the absorbed dose and not of the exposure time. By so doing, they established the fact that the use of electrons for food sterilization was commercially feasible, if continuously operating sources could provide the high absorbed doses necessary at a rate suitable to production requirements.

The magnitude of this part of the problem is easily understood when it is pointed out that the absorbed dose required is of the order of a few thousand to a few million rep and, if large quantities of material are to be processed, the beam power must be beyond that which is satisfactory for medical purposes. The usual one- or two-million-volt x-ray therapy unit operating at a beam current of $1^1/_2$ to 3 ma represents a beam power of about 3 kilowatts. This is sufficient for experimental electron studies where the material can be held in the beam for adequate exposure. It may also be sufficient for small, thin specimens in production quantities but is inadequate for most continuous production processes. Assuming that a million rep is a high enough dose for the desired result, 1 kilowatt of beam power will process approximately 1,000 pounds of unit density material per hour. When it is remembered that food processing may require the handling of tons of material per hour, some idea can be had of the beam powers required.

The major equipment design problem is one of high voltage for penetration at a depth, high beam currents for the delivery of large absorbed doses at conveyor belt speeds, and large area coverage to permit exposure of large packages.

Many of the experimental and developmental studies to date have been conducted with supervoltage x-ray units of the resonant transformer or electrostatic type, with a tube in which the target has been replaced by a thin metal window through which the electron beam emerges. Such sources are, of course, limited to small fields and relatively low beam power. The development of production processing sources involves higher beam powers and larger field coverage. Van de Graaff and Trump recognized that the depth of ray penetration is determined by the voltage and density of the absorbing material, while the area which is irradiated can be controlled by selection of window absorber distances, by magnetic deflection, and by suitable scattering arrangements. This suggests modified cathode ray tube principles, with the window at the end of a flared section, and employment of known scanning technics to obtain a beam rate consistent with the desired dose and conveyor speed. The chief problems in the design of these tubes have to do with the mechanical strength of the large window and dissipation of heat from the windows. In electron beam tubes the window must be cooled by a high-velocity stream of air, since the usual method of flowing water across it would absorb much of the useful beam. In very high-powered, large-coverage installations, the beam cannot be permitted to come to rest, since it would very promptly melt the window.

At the present time, equipment is commercially available to operate at energies up to 2 MEV and 6 ma (approximately 10

kilowatts) with a window area of 3 × 15 inches. Development is in progress on a 4-MEV, 10-ma unit (approximately 35 kilowatts). For higher voltages and higher beam intensity, it would seem that the linear accelerators operating at 25 to 50 MEV and presently unavailable beam currents may be the answer. At the higher energies, neutron production may make these energies impractical for some applications.

The problem in its essentials is one of providing electrons at an energy (voltage) sufficient to penetrate the material and a beam current high enough to deliver the required dose at the necessary production rate. In a general way it can be said that maximum electron penetration is about 0.5 cm. of unit density material per million electron volts. Hence a package of unit density material 3 inches thick would require a 15-MEV beam. For uniformity of absorbed dose it may be preferable to irradiate from two sides, either by turning over the package or by simultaneous irradiation from both sides. The problem of a uniform dose to an irregular container, such as a bottle, is a complex one and may well result in the reshaping of some of our familiar packages.

It may be in order here to consider the feasibility of using gamma sources instead of electron beams. This might solve the penetration problem but it reduces the available power. In the case of gamma or x-ray sources, the efficiency of conversion of electrons into x-rays is of a low order, at best a few per cent. The power available from isotopic sources is also limited. The fission product separation plant at present being constructed at Oak Ridge is reported as having an annual output of 200,000 curies of cesium 137. This represents about 1.5 kilowatts. Research, of course, can be done with gamma sources of several kilocuries, but the large power demands of industrial processes are not met with such sources. Spent reactor fuel elements are a possibility, but much of the radiation is of short half-life, and the problem of transportation of source to material or material to source is a complex one. A nuclear reactor of special design is another possibility. While it may be possible to develop high-power facilities, the location of the reactor near the source of material becomes a complex problem. This is especially true for seasonal food products, processing facilities for which must be near the growing area.

In view of the foregoing considerations, it can be said that at present the widespread application of ionizing beams in industrial processes would seem to involve the use of some form of electron accelerating machine.

Recent interest in the electron beams has been directed toward two types of application, complete or partial sterilization and the initiation or production of chemical changes. At the present time electron beams are being used to sterilize some pharmaceuticals and some surgical materials. It is quite logical that this should be the case, since these represent situations in which sterilization by heat may produce undesirable changes. At the same time, the area to be irradiated is a small one and thicknesses are not great. An example is an eye ointment sold in a plastic box containing four ampules which have been sterilized, after filling, by exposure to an electron beam. It is interesting to note that, instead of the conventional spherical or ovoid ampules with the resulting dosimetry problem, flat design providing a uniform section has been used. Another such product is a plastic surgical tubing, sterilized after packing in its plastic container.

Perhaps a more dramatic application is the sterilization of blood vessels prior to storage in a blood vessel bank. Removed under unsterile conditions at autopsy, they are frozen, electron sterilized, and stored in the frozen condition until needed. There are at present two blood vessel banks using this method.

The field of food preservation is probably receiving more attention than any other. It has been estimated that not less than $2,000,000 is being spent annually on studies in this field. Although it has been

known for many years that microorganisms are destroyed by ionizing radiation due to a chemical change within the organism, the exact nature of this change is still not clearly understood. It is the aim of researchers in the field to develop preservation technics that will be less destructive to the necessary nourishing elements, will not require refrigeration, and will perhaps result in preservation of foods that by present methods cannot be preserved. In the achievement of this end, it is expected that problems may be encountered in the way of altered taste, undesirable odor, etc. It should be noted, however, that what are undesirable food characteristics in some parts of the world are considered quite desirable by gourmets in other parts. Taste and the enjoyment of it are the result of habit, availability, and custom. It may well be that some of the presently undesirable side-effects of a new method of food technology would be tolerated and even enjoyed by a generation with changed taste habits. Witness a large portion of our present population which has never tasted mother's home-made bread, fresh from the oven and spread with her unsalted butter.

The most ambitious program of this kind is being carried out by the Quartermaster Food and Container Institute of the Armed Forces, with the assistance of the Office of the Surgeon General. This project, which has been going on for about three years, has studied the irradiation characteristics of many foodstuffs. The irradiated materials have been fed to experimental animals without toxic or negative effects. Vitamin loss is reported as being of the same order of magnitude as that encountered in heat processing, with the reservation that vitamin E is extremely sensitive to radiation. Results in general are satisfactory. Irradiated pork has been stored at 70° F. for periods as long as nine months, during which it has retained its color, acceptability, and nutritional values. Sliced bacon that has been irradiated can be stored about three times as long as the unirradiated product. This is of importance to the military economy, since it means that bacon having the same salt content as the civilian product can be purchased for Armed Service personnel. Fowl has been irradiated in both the fresh and partially cooked state. After storage for four months at 70° F. it was not different from the frozen control, when prepared for the table. Potatoes have been irradiated successfully to prevent the growth of sprouts.

The Army is building a $7,500,000 facility near Stockton, Calif., to be used in its continuing studies of preservation by ionizing radiation. It will include a nuclear reactor of special design and a high-energy accelerator. The pilot plant scheduled to go into operation in late 1958 is to have a rated capacity of 1,000 tons per month at a 2-megarep dose in unit density material based on a twenty-four-hour-a-day operation, twenty-eight days per month. The future of ionization preservation of foods will depend on the relative results and costs of this method compared with thermal technics.

The action of high-energy electrons can be used to produce a wide variety of chemical effects, depending on the nature of the chemical system. The effect that has already been incorporated into industrial processes is that produced in solid polymers generally known as plastics. Most useful has been the effect called crosslinking or "curing." This process ties together the long, chain-like molecules that make up these materials. These crosslinked products generally have greater form stability and higher solvent resistance than the unirradiated parent material. The familiar polyethylene "squeeze" bottle is deformed into a shapeless lump at rather low temperatures. Low-dose irradiation produces a material so stable that it may even be steam sterilized. Nylon, rubber, and silicone products also lend themselves to this treatment.

One of the first, if not the first, product resulting from irradiation processing is an irradiated polyethylene tape used as electrical insulation. The irradiated tape will

withstand temperatures that render the unirradiated product useless.

Some of the plastic materials are depolymerized by irradiation, with a resultant decrease in molecular weight. This process, referred to as degradation, is not always harmful, as the reference term might connote; it may, indeed, be a useful process. Dextran, for example, which is used as a blood extender or substitute for plasma, in its original form is a polymer of high molecular weight produced by bacterial action on certain sugars. It does not lend itself to medical use unless broken down into a lower molecular weight. This can be done by chemical processing of a complicated nature, but the same result can be produced by irradiation with relatively simple processing.

Another interesting effect can be produced in liquid polymers, which upon irradiation crosslink to form a solid material. With this process, it is possible, by shaped shielding over the liquid polymer, to produce a solid of the desired shape. Such a process does not involve the use of a catalyst and the high temperatures usually employed.

It is out of the question even to list here all the possibilities being considered for the use of electron beams for industrial processing and research. To do so would call attention to possible new synthetic fuels produced from natural crude materials, new concepts of food packaging and marketing, new materials produced by new processes, all serving to alter our lives and our economy.

It would be unusual and unexpected if this essayist, addressing a group of radiologists, failed to relate these technics to their impact on the growing problem of radiation protection. They constitute only one of many new fields employing ionizing radiation, each of which contributes to the increased exposure of a large portion of the world population.

Some of the problems encountered in electron-beam technics are peculiar to these applications. Although the beam that emerges from the tubes is an electron beam, the x-rays produced by it when it strikes materials and structures, are unique to most of us only in that they are produced outside the accelerating tube. Of a diffuse and uncollimated nature, they pose a problem of protection from radiation produced in and around a large-volume source. The electrons themselves have long paths in air and their energy loss by ionization, excitation, scattering, and production of x-rays is complex and not easily reduced to a set of simple formulae.

The National Committee on Radiation Protection has a subcommittee working on the problem. The magnitude of their task may be judged by the fact that they are charged with providing protection recommendations for electron energies from 500 kev to 50 MEV and beam powers up to 100 kilowatts. To this must be added the fact that a high-velocity air blast is used to cool the tube window, resulting in the production of great quantities of ozone, which is itself a noxious gas and must be exhausted into some safe area or scrubbing system. Conditions governing entrances into the irradiation area are quite different from those of a medical x-ray installation, in that a continuous flow of material into and from the area must be provided. Conventional conveyor technics are not applicable, since ordinary belt materials disintegrate quickly under electron bombardment. All metal structures in the irradiation area are subjected to the corrosive action of the ozone-laden atmosphere. Even the usual safety interlock devices are subject to question, since electrical insulating materials may deteriorate rapidly due to bombardment by electrons and x-rays. Sudden stoppage of the conveyor system without interruption of the beam may result in a fire started in the irradiated material by the absorbed energy. By comparison, the development of safe principles for a high-energy therapy installation seems quite simple. Nevertheless, the problem will be solved, for the need is urgent.

To those of us here it is once more apparent that we must survey and weigh the radiation used in medical procedures, for

they now represent only one of the many demands for a portion of the safe lifetime dose to our population. For, whether we like it or not, others are going to use radiation sources which will contribute to the total population dose. Each such new use will generate further pressure to limit the amount of radiation which may be administered in medical procedures. It is essential that our radiological technics be such as to alleviate rather than aggravate this growing problem.

Acknowledgment must be made to the many who contributed material, ideas, and knowledge that have gone into this paper. Among these, special mention should be made of Dr. W. D. Coolidge, of Dr. Kenneth Kingdon, Dr. W. F. Westendorp, Dr. E. J. Lawton, and Dr. W. D. Bellamy of the General Electric Research Laboratory, and of J. D. Webster and J. W. Ranftl of the X-Ray Department.

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## SUMMARIO IN INTERLINGUA

### Le Use de Fasces de Electrones in Processos Industrial

Le uso de fasces de electrones in processos industrial e le problemas sublevate per tal applicationes es discutite. Le principal campos de interesse es usque nunc illos concernite con le preservation de alimentos, le sterilisation de materiales chirurgic e de productos pharmaceutic, e le initation e acceleration de reactiones chimic. Le fontes de fasces de electrones currentemente in uso es simile al fontes de radios X usate in le therapia radiational. Le problema del protection contra le radiation presenta certe aspectos unic, proque energias electronic ab 500 kev usque a 500 MEV e potentias de fasce usque a 100 kilovolts debe esser prendite in consideration. In comparation con isto, le disveloppamento de principios secur pro installationes de therapia a alte energia appare relativemente simple.

In vista de iste nove applicationes, radiologos clinic va esser exhortate a limitar le quantitate de radiation administrate in procedimentos medical al minimo essential.

# Intravenous Cholangiography as an Aid in Diagnosis of Carcinoma of the Head of the Pancreas[1]

GEORGE LEVENE, M.D., and SAUL SCHEFF, M.D.

THE PANCREAS consists of a head, neck, body, and tail. The most frequent site of carcinoma is the head. While the roentgenologic signs of advanced carcinoma of the head of the pancreas are as a rule readily recognized, the early lesion may be quite difficult to detect. Any additional information which may assist in establishing the diagnosis is therefore of interest.

Typically, the "bile duct is about three inches long and of variable width—usually a quarter of an inch. It begins at the mouth of the porta hepatis, where it is formed by the union of the cystic and common ducts. In the first part of its course it passes between the two layers of omentum, with the portal vein behind and the hepatic artery to its left. It then descends behind and to the left of the first part of the duodenum and runs, with a curve, downward and to the right to its termination. In the third part of its course, it is usually embedded in the head of the pancreas. It may also, in other specimens, pass behind the head of the pancreas close to the inferior vena cava or, again, in the angle between the head of the pancreas and the duodenum, more or less embedded in the pancreatic tissue. Finally, it meets the pancreatic duct and, with it, pierces the medial wall of the second part of the duodenum very obliquely, and opens on the duodenal papilla about three and a half inches beyond the pylorus (1)."

The common duct is subject to developmental variations. Eisendrath (2) described ten of the more common anomalies of the bile ducts, but in none of these did the common duct show a convexity to the right or an abrupt change in caliber. Sachs and Partington (4) described changes in the course and caliber of the common duct in pancreatitis and stated that such findings may occur in carcinoma of the head of the pancreas. Their patients, however, showed signs of obstructive jaundice, and their studies were made by injecting the common duct through a "T" tube at the time of operation. Poppel (3) described displacement of the common duct in cases of carcinoma of the head of the pancreas, but his work, also, was based on opacification of the common duct through a "T" tube at operation or in the immediate postoperative period.

Our report is based on examination made after intravenous injection of a selective contrast medium (Cholografin) in patients without clinical or laboratory evidence of jaundice. This method, therefore, offers an opportunity for the recognition of carcinoma of the head of the pancreas in its earlier stages.

It becomes apparent that the common duct, because of its intimate anatomical relationship to the head of the pancreas, is, when opacified, in a strategic position to reveal abnormal enlargement of that structure (Figs. 1 and 2). As the head of the pancreas increases in size, it carries the common duct with it, and the latter assumes a curved form with its convexity to the right (Figs. 3 and 4). We believe that this sign, when present, definitely localizes a mass to the region of the head of the pancreas. Since pancreatitis may cause tumefaction of the body of the pancreas as well as the head, careful study of the history and laboratory findings is necessary for differential diagnosis. When the common duct is not well visualized on routine intravenous cholangiograms, it may often be brought clearly into view by laminagraphy.

The usefulness of this method in the di-

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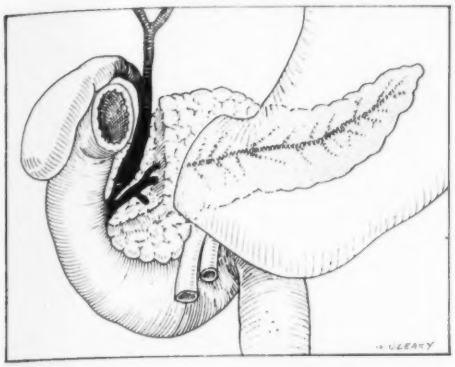

Fig. 1. Semidiagrammatic illustration showing the average typical course of the common duct through the head of the pancreas.

Fig. 2. Gallbladder, common duct, pancreas, and descending duodenum removed *en bloc*. The normal common duct is straight, or, if curved, convex to the left.

agnosis of carcinoma of the head of the pancreas is shown in the following illustrative cases:

CASE I: A man of 76, who had a cholecystectomy eleven years previously, complained of dull pain in the right upper quadrant and weight loss. The pain was intermittent, non-radiating, and unrelated to food. X-ray examination elsewhere was reported as showing no evidence of organic disease of the gastrointestinal tract. On examination in the hospital all of the laboratory procedures, including bilirubin determination and icteric index, gave values well within normal limits. Intravenous cholangiograms showed a definite curve in the course of the common duct, with a convexity to the right. To render the structure more clearly visible, laminagrams were made (Fig. 5). The abnormal course of the common duct was clearly apparent. Our diagnosis of carcinoma of the head of the pancreas was confirmed at operation. Microscopic study of the neighboring lymph nodes showed no tumor cells.

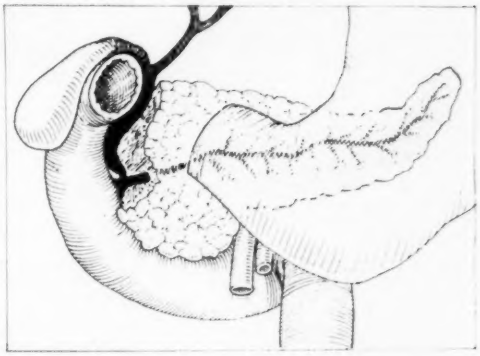

Fig. 3. Semidiagrammatic illustration showing the typical displacement deformity of the common duct in carcinoma of the head of the pancreas.

CASE II: A man of 71 was admitted to the hospital with aching pain in the epigastrium, radiating

Fig. 4. Postoperative cholangiogram through a T tube in a case of advanced carcinoma of the head of the pancreas. The pancreatic portion of the common duct is displaced and curved, with the convexity to the right.

Fig. 5. Case I: Laminagram obtained after intravenous injection, showing the typical deformity of the common duct.

Fig. 6. Case II: Intravenous cholangiogram (retouched) showing the deformity of the common duct due to carcinoma of the head of the pancreas. There was no jaundice, and the icteric index and bilirubin were normal.

to the lower abdomen, anterior chest, and back. Two weeks prior to entry, the patient experienced weakness, dyspnea on exertion, and pain in the extremities. He complained of constipation and the passage of blood in the stools. X-ray examination elsewhere twelve months, six months, and six weeks, prior to admission had shown only a small sliding hiatus hernia. Examination in our hospital revealed a hiatus hernia, a polyp of the sigmoid, and questionable widening of the duodenal loop. Laboratory studies showed a severe anemia due to blood loss and guaiac-positive stools (2+). The icteric index and bilirubin determinations were normal. Intravenous cholangiography was advised, and an abnormal convexity of the common duct was demonstrated (Fig. 6). (Circumstances did not permit laminagraphic study.) Our diagnosis of carcinoma of the head of the pancreas was confirmed at operation. Regional nodes were negative microscopically for tumor.

## SUMMARY

A portion of the common bile duct is embedded in the head of the pancreas. With enlargement of the latter structure as the result of an expanding tumor, the common duct is displaced and deformed in a typical pattern. Study of the common bile duct by intravenous cholangiography is therefore a valuable adjunct in the early diagnosis of carcinoma of the head of the pancreas.

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## SUMMARIO IN INTERLINGUA

### Cholangiographia Intravenose Como Adjuta in le Diagnose de Carcinoma del Capite del Pancreas

Durante que le signos roentgenologic de avantiate carcinoma del capite del pancreas es—como regula general—facile a recognoscer, le minus avantiate lesion non se detege tanto facilemente. In tal casos, cholangiographia es utile e pote resultar in un prompte diagnose.

Un portion del ducto biliari commun es situate in le capite del pancreas, e quando isto—in le presentia de un tumore crescente—deveni de plus in plus grande, le ducto commun es movite con illo e disveloppa un forma curve con convexitate sinistrorse. On crede que iste signo localisa un massa in le region del capite del pancreas. Studios laboratorial e le historia clinic del patiente debe esser prendite in consideration in establir le differentiation inter pancreatitis e cancere.

Duo casos illustrative es reportate.

# The Technic of Cervical Discography[1]

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THE FOLLOWING simple technic for discography has been found useful by the authors in the study of cervical disk disorders.

The patient is placed in the supine position on the x-ray table, with two folded sheets directly under the shoulders to give hyperextension to the neck. The head is turned

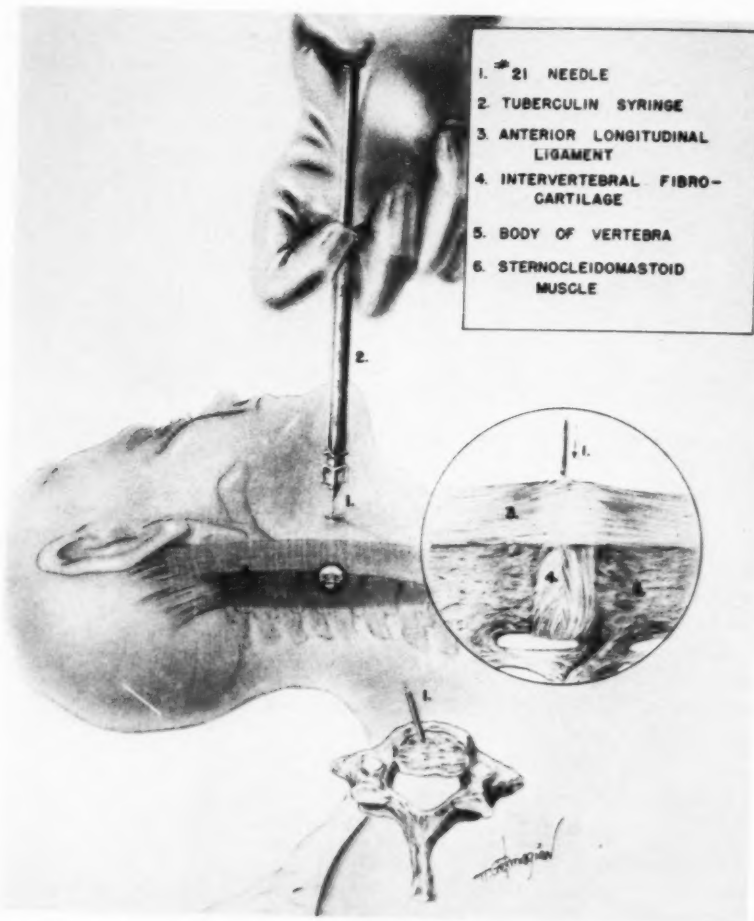


Fig. 1. Position of the head for cervical discography. The circle insert shows the needle entering the disk space. The relationship of the needle to the disk space is shown in the lower insert.

Ninety-six milligrams of sodium luminal and 16 mg. of morphine sulfate are given forty-five minutes prior to the procedure.

approximately 10° to the side opposite the site of injection (Fig. 1). The anterolateral aspects of the cervical region are

[1] From the Division of Neurological Surgery, The Medical College of Georgia, Augusta, Ga. Accepted for publication in December 1956.

prepared with ether and Zephiran and 0.5 ml. of 1 per cent procaine is injected into the skin and subcutaneous tissues at the level of the thyroid cartilage, 4 cm. from the mid-line. A 9-cm., 21-gauge spinal needle is then introduced anteriorly in the cervical region at an angle of approximately 30°, toward the mid-line, until the anterolateral surface of the sixth cervical vertebra is encountered. The needle is then "walked" cephalad to the fifth interspace, which is recognized by the absence of resistance. It is then advanced so as to puncture the anterior longitudinal ligament. After the disk space is entered, the needle is advanced approximately 1 cm. to the center of the disk (Fig. 2). The injection is usually made on the side opposite that of the clinical root signs. The contrast medium, 70 per cent Diodrast, 0.5 to 1.0 ml., is injected slowly by means of a tuberculin syringe. Resistance encountered in making the injection suggests that the disk may be normal. Usually this amount of Diodrast passes readily into the disk space with relatively slight resistance.

If the disk space being injected is diseased, the patient quickly complains of severe shoulder, arm, hand, and finger pain, or paresthesias simulating his admission complaints. He will complain also of posterior cervical and suboccipital pain, as well as referred interscapular and anterior chest pain, if these have been a part of the original syndrome.

Regular cervical spine roentgenograms, including oblique views, are promptly obtained. Since Diodrast is a water-soluble iodine solution, it is readily absorbed and disappears in the disk space in a matter of sixty to ninety minutes.

This technic offers several advantages. It can be employed as an out-patient test or study. Direct information is obtained regarding the disk and the disk space. The contrast medium is quickly absorbed, obviating the necessity of its removal. Fluoroscopy is not required and with moderate experience the examination can be accomplished in fifteen to twenty minutes. The patient suffers little morbidity.

Fig. 2. Anteroposterior and lateral films of the cervical spine showing the position of the needles.

There is no contamination of the meninges by lumbar puncture nor of the subarachnoid spaces of the central nervous system by the contrast material. Considerable clinical information regarding the neck is afforded by the radiating and referred pain when the diseased interspace has been injected. Quite definite information can be obtained regarding the rupture of the disk laterally in the region of the joint of Luschka, and along the nerve root in the foramen. This technic also permits the injection of a dye such as methylene blue into the disk space when subsequent surgery is desired. This aids proper localization at the surgical table.

The disadvantages of the procedure are that it affords no information about the cerebral spinal fluid pressure, dynamics, and chemistry, or regarding the cervical spinal cord.

No complications have been encountered in 70 cases studied by this technic, including injections at all levels from C-3 through C-7. The results obtained in this series will be the subject of a report to be published later.

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SUMMARIO IN INTERLINGUA

**Le Technica de Discographia Cervical**

Le autores describe un technica de discographia que ha provate su utilitate in le studio de disordines de discos cervical. Diodrast (75 pro cento) in un amonta de 0,5 a 1,0 ml es introducite directemente in le spatio discal. Postea roentgenogrammas, incluse vistas oblique, es obtenite promptemente. Iste manovra provide informationes directe in re la disco e le spatio discal. Le substantia de contrasto es absorbite rapidemente, e il non es necessari abferer lo. Fluoroscopia es non requirite e le examine pote esser complite in dececinque a vinti minutas.

Le technica esseva usate in septanta patientes sin effectos adverse.

# The Radiographic Features of Severe Idiopathic Hypercalcemia of Infancy

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IDIOPATHIC hypercalcemia in infants is a disorder of calcium metabolism generally unknown to the radiologist, but being recognized with increasing frequency by our pediatric colleagues as a specific abnormality. The disease usually has an abrupt onset in early infancy, after several months of normal development. It is manifested clinically by loss of weight, anorexia, constipation, vomiting, and hypotonia. Laboratory studies disclose hypercalcemia, elevation of the blood urea, and occasionally evidence of renal acidosis. These features are present in the two recognized forms (1) of the disease, the one transient and the other chronic and severe.

In the more common transient type the disease is benign and self-limiting after a course of several months, and there are no distinctive roentgen findings. All reported cases (2–6) of the severe chronic form, on the other hand, have shown signs of physical and mental retardation, hypertension, systolic heart murmur, fretfulness, and radiographic evidence of osteosclerosis. It is the purpose of this paper to bring to the attention of the radiologist the roentgen features of the severe form of idiopathic hypercalcemia. A more detailed account of the clinical and laboratory features of the case has appeared elsewhere (7).

## CASE REPORT

N. H., a 17-month-old white female infant, was admitted to the Texas Children's Hospital on April 5, 1954, because of failure to develop normally. She was born prematurely on Nov. 2, 1952, after a precipitous labor of thirty minutes at about seven and one-half months of an uncomplicated second pregnancy. Her birth weight was 3 pounds 14 ounces. Development had been normal until the age of six months, at which time the weight was 12 pounds 2 ounces. There had then occurred an abrupt cessation of growth. At four months of age the child became irritable, and constipation developed, requiring daily suppositories. From birth to three months of age she was given Alactin, and then an evaporated milk formula. At ten months of age this was changed to Similac 1:1. Solid baby foods, which were begun at three months, were taken readily on occasion but poorly after the age of six months. Supplemental vitamins had been given in normal quantities. Teething began at approximately seven months, and between that age and seventeen months six incisor teeth had made their appearance. At ten months of age the child could roll from side to side but could not sit alone or crawl. At thirteen months a partial paralysis of the left side of the face occurred. Recovery ensued within thirty days but was followed by a gradual weakness of the right side of the face.

Physical examination at seventeen months showed the patient to be about the size of a six-month infant, both physically and mentally retarded. She cried fretfully and was unable to sit or crawl. She could not talk but uttered an occasional unintelligible sound. Her weight was 12 pounds and her length 26 inches. Temperature, pulse, and respirations were within normal limits, and the blood pressure was 90/60 mm. Hg. Asymmetry of the face was present as a result of the partial right facial nerve paralysis. The anterior fontanel was closed. Examination of the neck revealed no masses or other abnormalities. The lungs were clear to percussion and the heart sounds were normal, no murmurs being heard. The abdomen was soft and non-tender, and the liver and spleen were not enlarged. The deep tendon reflexes were hypoactive.

*Laboratory Studies:* On admission the hemoglobin was 12.3 gm. Urinalysis showed evidence of a mild urinary tract infection, which responded to Chloromycetin. There was no evidence of heavy metal poisoning. The highest urinary concentration was found to be 1.011. The electrocardiogram was reported as normal. Blood chemistry studies showed elevation of serum calcium ranging from 13.3 to 15.2 mg. per cent. Phosphorus levels were also high, the average being approximately 6.5 mg. per cent. Alkaline phosphatase on two occasions was 6.8 and 5.4 Bodansky units. The serum proteins were consistently elevated from 6 to 9.6 gm. The blood urea nitrogen was high, 51.5 mg. per cent being the lowest recorded value. The sodium, chloride, and potassium levels were also persistently above normal. Cholesterol values were extremely high,

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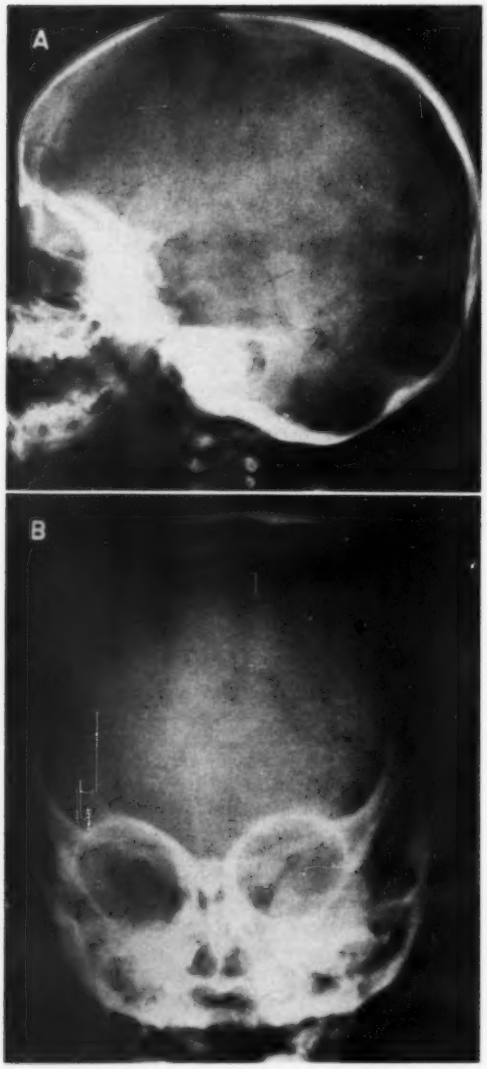


Fig. 1. A. Lateral roentgenogram showing increased density of the cranial vault and base of the skull. Slight buckling is present at the anterior fontanel.
B. Postero-anterior roentgenogram demonstrating complete closure of the anterior fontanel and obliteration of the sagittal suture.

ranging from 326 to 588 mg. per cent. Iodine uptake studies demonstrated no abnormality of thyroid function.

*Roentgen Findings:* Radiographs obtained on April 6, 1954, showed a generalized increased density of the cranial vault and the base of the skull (Fig. 1A). The configuration and size of the cranium were not unusual, but the sagittal suture appeared obliterated (Fig. 1B). There was no evidence of increased intracranial pressure, and the sella turcica was not abnormal. The anterior fontanel was closed. Skull films made elsewhere, seven months previously, showed similar but less pronounced density of the cranial vault. The sagittal suture at that time was of normal width, although the anterior fontanel was closed. The lamina dura was indistinct but the overall density of bone about the teeth was increased.

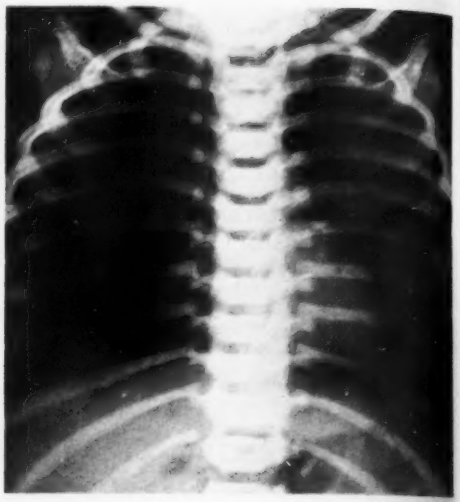

Fig. 2. Postero-anterior chest roentgenogram showing abnormal density of the ribs and dorsal spine.

Chest roentgenograms indicated no abnormality of pulmonary or mediastinal structures. The ribs and shoulder girdles showed a generalized increase in density (Fig. 2). Films of the upper extremities also demonstrated an increase in bone density. A localized zone of periosteal new bone formation was present on the medial aspect of the upper diaphysis of each humerus. This was interpreted as being an area of traumatic periostitis incident to repeated lifting of the infant by the arms because of her physical debility. Alternating bands of increased and normal density were prominent in the distal ends of each radius and ulna (Fig. 3). Similar but less prominent findings were present in the distal ends of the metacarpals. Two small carpal bones were identified, which, together with a small underdeveloped distal radial epiphysis on the left, denoted delayed osseous maturation.

Films of the lower extremities showed absence of normal tubulation, each femur having a "celery stalk" configuration. Alternating bands of sclerosis and radiolucency were prominent at the distal ends of the femurs and at the metaphyseal ends of the tibiae and fibulae (Fig. 4). The trabecular pattern of both upper and lower extremities was coarsened and poorly

defined. The sclerotic process appeared to involve the entire bone substance, the cortex of the shaft of each of the long bones being not disproportionately thick and the medullary cavity maintaining a relatively normal thickness. The epiphyses about the knees were of normal size but were abnormally dense and amorphous in appearance.

The vertebral bodies were small and underdeveloped, with an increase in density, particularly at the superior and inferior borders (Fig. 5).

Excretory pyelography, performed on two separate occasions, showed poor concentration of con-

Fig. 3. Roentgenograms of the right and left upper extremities showing generalized osteosclerosis with transverse bands of increased density in the distal metaphysis of each radius and ulna.

Fig. 4. Roentgenograms of the lower extremities showing generalized osteosclerosis without appreciable cortical thickening. Alternating bands of increased and decreased density are prominent in the metaphyses.

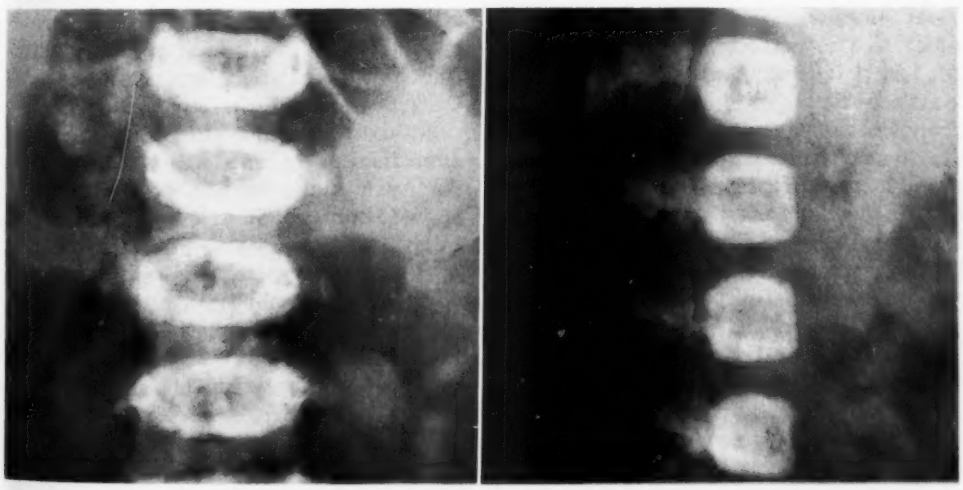

Fig. 5. Anteroposterior and lateral roentgenograms of the lumbar spine showing thickening and increased density of the superior and inferior surfaces of each vertebra.

trast material (70 per cent Urokon) without adequate visualization of either collecting system. Each renal silhouette was of normal size, but the overall density was thought to be slightly increased, although definite calcification was not identified.

Examination of the upper gastrointestinal tract showed no abnormality of the esophagus or stomach, but there was slight delay in transit time of the barium meal through the small bowel.

The patient was discharged unimproved on May 15, 1954. She followed a downhill course, succumbing several months later in another State. Postmortem examination was not obtained.

## DISCUSSION

In its history, physical features, clinical and laboratory findings—mental retardation, hypercalcemia, acidosis, increased plasma proteins, hypercholesterinemia—and radiographic picture of generalized bone sclerosis, this case is identical with the other cases of severe idiopathic hypercalcemia reported in infants. The normal blood pressure in this instance probably accounts for the absence of a cardiac murmur, which was present in the other cases.

The etiology of the disease is obscure. There apparently exists in these children an abnormal sensitivity to Vitamin D, resulting in an excessive absorption of calcium from the gastrointestinal tract, hypercalcemia, renal parenchymal calcification, acidosis, failure to thrive, and death. Other theories, involving primary renal disease, primary hyperparathyroidism, generalized constitutional defects, and excessive ingestion of alkali, have been proposed (6).

A detailed discussion of the disorder of calcium metabolism in this condition is left to more qualified observers, but it is necessary to consider in detail the radiographic characteristics, particularly the osseous abnormalities, in an effort to establish the condition of severe infantile hypercalcemia as a recognizable radiologic entity.

The long bones of our patient, as well as in all previously reported cases, showed increased density of the cortex as well as of the trabecular structure. There are many known conditions characterized by sclerosis of bone, none of which fits the overall appearance found in idiopathic hypercalcemia. The sclerotic process resembles to some extent the bone changes of osteopetrosis. The medullary cavity, however, is preserved, and the cortex does not have the thickness, particularly in the metaphyseal regions, exhibited by severe forms of the latter disease. It is of interest that this case, as well as several of the previously reported cases, were initially mistaken for atypical forms of osteopetrosis. The presence of facial paralysis in this instance was further evidence in favor of that diagnosis but, because the paralysis was transient, it was not felt to be the result of encroachment on the facial nerves by the sclerotic process. In addition, the absence of anemia, liver and spleen enlargement, and other clinical features of osteopetrosis, as well as the laboratory data as to hypercalcemia and acidosis, excluded this condition.

In idiopathic hypercalcemia, primary hyperparathyroidism is of necessity considered high in the list of differential diagnoses. The normal or elevated serum phosphorus levels and the normal alkaline phosphatase levels, however, tend to discredit that diagnosis. In addition, the bone changes of hyperparathyroidism consist in demineralization rather than sclerosis. Moreover, such signs of hyperparathyroidism as subperiosteal resorption of bone in the phalanges, the typical granular decalcification of the skull, and cyst formation are not present. A high milk consumption in infants with hyperparathyroidism would prevent osseous demineralization but should not lead to increased bone density. Because of the similarity of idiopathic hypercalcemia to hyperparathyroidism in many respects, irradiation of the parathyroid region (5) has been tried, but without beneficial results.

Hypoparathyroidism has been listed as a cause of generalized increase in bone density, but not of the degree found in infantile idiopathic hypercalcemia. Furthermore, the elevated serum calcium excludes hypoparathyroidism as a responsible cause.

Chronic renal acidosis in infants may be clinically indistinguishable from idiopathic hypercalcemia, but in such cases the bone changes will be those of rickets or osteomalacia (8).

The osteosclerosis occasionally seen in premature infants closely resembles that of idiopathic hypercalcemia. In the former condition, however, the sclerosis is due to proportionately thicker cortical bone and more abundant spongiosa during the fetal and neonatal periods and gradually disappears during the first weeks of life (9). In idiopathic hypercalcemia, the sclerotic process begins after the neonatal period and becomes progressively more severe.

Myelofibrosis and myelosclerosis are rare causes of increased bone density in adults, but have not been reported in infants, and the clinical and laboratory features are unlike those of idiopathic hypercalcemia.

In Engelmann's disease (progressive diaphyseal dysplasia), the sclerotic process affects only the diaphyseal portion of the bones, makes its appearance at a more advanced age, and does not show the clinical or laboratory features of hypercalcemia.

Vitamin D intoxication produces generalized demineralization of bone rather than sclerosis in the adult (10). In infants and growing children, increased ingestion of vitamin D has led to dense deposition of mineral in the provisional zone of calcification in the metaphyses of the long bones (11), as well as non-specific striping of the metaphyses with bands of both increased and decreased densities (9). However, sclerosis of the entire osseous system, including the diaphyseal portions of the long bones, has not, to the writer's knowledge, been reported in infants with hypervitaminosis D alone.

The radiographic findings in infants who have received excessive amounts of vitamin A consist of periosteal cloaking of the long bones and are similar to the changes noted in infantile cortical hyperostosis. The appearance is distinctly different from that of idiopathic hypercalcemia, and the clinical features are entirely dissimilar. Generalized diffuse osteosclerosis has been reported in conjunction with high intake of vitamin A and D (12), but in the reported cases of idiopathic hypercalcemia, vitamin intake has not been excessive.

Fluoride poisoning is said to produce generalized increase in bone density such as one might expect to encounter in idiopathic hypercalcemia, but this condition should readily be excluded by careful history taking, as well as by the laboratory findings. Heavy metal poisoning—bismuth, phosphorus, or lead—will produce dense provisional zones of calcification but not the homogeneous density encountered in idiopathic hypercalcemia.

The transverse bands of increased density alternating with bands of relatively normal density observed in the metaphyseal ends of the long bones in the case reported here are not specific, being found in many generalized bone disorders, including most of those already mentioned in consideration of the differential diagnosis. These bands of increased density are probably more prominent in those disorders which severely affect the normal rate of osseous growth. In our experience, chronic renal disease with repeated bouts of acidosis has been a common cause for the appearance of these "growth disturbance" lines. Any illness, however, which produces a toxic effect upon the cellular activity of the epiphyseal regions will show similar "building up" of the provisional zones of calcification, with resulting incorporation of these lines in the metaphyseal portions as a more normal rate of growth is resumed. The absence of normal tubulation in this case is apparently another disorder of bone growth involving for the most part the appositional formation of bone in the diaphyseal and metaphyseal regions, and not a specific finding.

Craniostenosis has been reported in 2 cases of idiopathic hypercalcemia (2, 3), and probably in a third (5). The apparent obliteration of the sagittal suture in our case suggests that early sclerosis of

the cranial sutures may not be an unusual finding in this disease.

The foregoing observations constitute evidence of a specific abnormality of unknown etiology characterized by hypercalcemia with associated failure of normal development and a roentgenographic picture of bone sclerosis. This condition is probably a severe form of the more common type of idiopathic hypercalcemia of infancy.

SUMMARY

Two forms of idiopathic hypercalcemia of infancy are recognized: a benign self-limiting type and a severe type characterized by signs of mental retardation, hypertension, failure of normal development, and bone sclerosis. A case of the latter variety in a seventeen-month-old infant is reported, with special emphasis on the radiological features.

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SUMMARIO IN INTERLINGUA

## Aspectos Radiographic de Sever Hypercalcemia Idiopathic de Infantia

Es recognoscite duo formas de hypercalcemia idiopathic de infantia: Un forma benigne que es auto-limitante e un forma sever que es charactersiate per signos de retardo mental, hypertension, dysplasia, e sclerosis ossee. Es reportate un caso del secunde de iste formas occurrente in un infante de dece-septe menses de etate que non se habeva disveloppate normalmente. Attention special es prestate al constatationes radiologic.

Le processo sclerotic in le ossos resimila in un certe grado illo de osteopetrosis, sed le cavitate medullari es preservate, e il non occurre ulle spissification disproportionate del cortice. Il pare plus tosto que le substantia total del osso es afficite. In le patiente del autor il habeva un alternation de bandas de sclerosis e de radiolucentia al extremitate distal del femore e al extremitate metaphyseal del tibias e fibulas. Le corpores vertebral esseva parve e subdisveloppate, con augmento de densitate del fornice cranial e del base del cranio. Le sutura sagittal appareva oblitterate.

# Ophthalmic Artery Aneurysm[1]

RALPH R. GOLDIN, M.D.[2], and MAURICE L. SILVER, M.D.[3]

ANEURYSM OF THE ophthalmic artery is quite uncommon and its preoperative demonstration has rarely been reported. Kinley and Leighninger (1) published a case of traumatic aneurysm in the region of the ophthalmic artery secondary to a compound comminuted fracture of the frontal bone involving the supra-orbital ridge and roof of the orbit. They were able to demonstrate the aneurysm by angiography two months after the injury. Their case may, however, have been a variant of a carotid-cavernous aneurysm, rather than an aneurysm of the ophthalmic artery. We have found no other instance in which the aneurysm was visualized preoperatively. The present case occurred without trauma and was discovered on angiography. Changes in the optic foramen seen on the plain films might have led one to suspect the specific diagnosis of ophthalmic artery aneurysm.

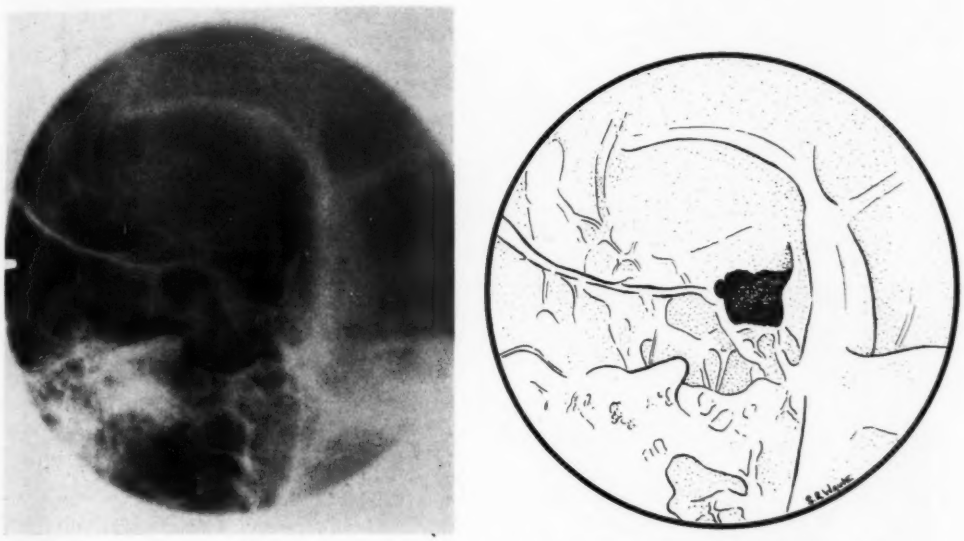

Fig. 1. Left optic foramen showing marked destruction of the outer wall. The inner wall is intact.

## CASE REPORT

A fifty-year-old female was admitted to the Miriam Hospital with progressive visual loss in the left eye of three months duration. At that time she was recovering from an upper respiratory infection and complained of severe headaches, followed by blurring of vision. Her vision became progressively worse, dropping from 20:20 to 20:400. She was seen by three ophthalmologists who felt that her symptoms were caused by retrobulbar neuritis.

Vision in the right eye was absent as a result of a childhood injury to the right globe and a cataract of the right lens. Hypertension was discovered two years previously and with diet her weight declined from 217 to 178 pounds.

Examination of the right eye revealed a dense lenticular opacity which allowed light perception, but no projection of the position of the light. With the left eye, the patient could detect only shape and movement. There was nasal hemianopsia on the

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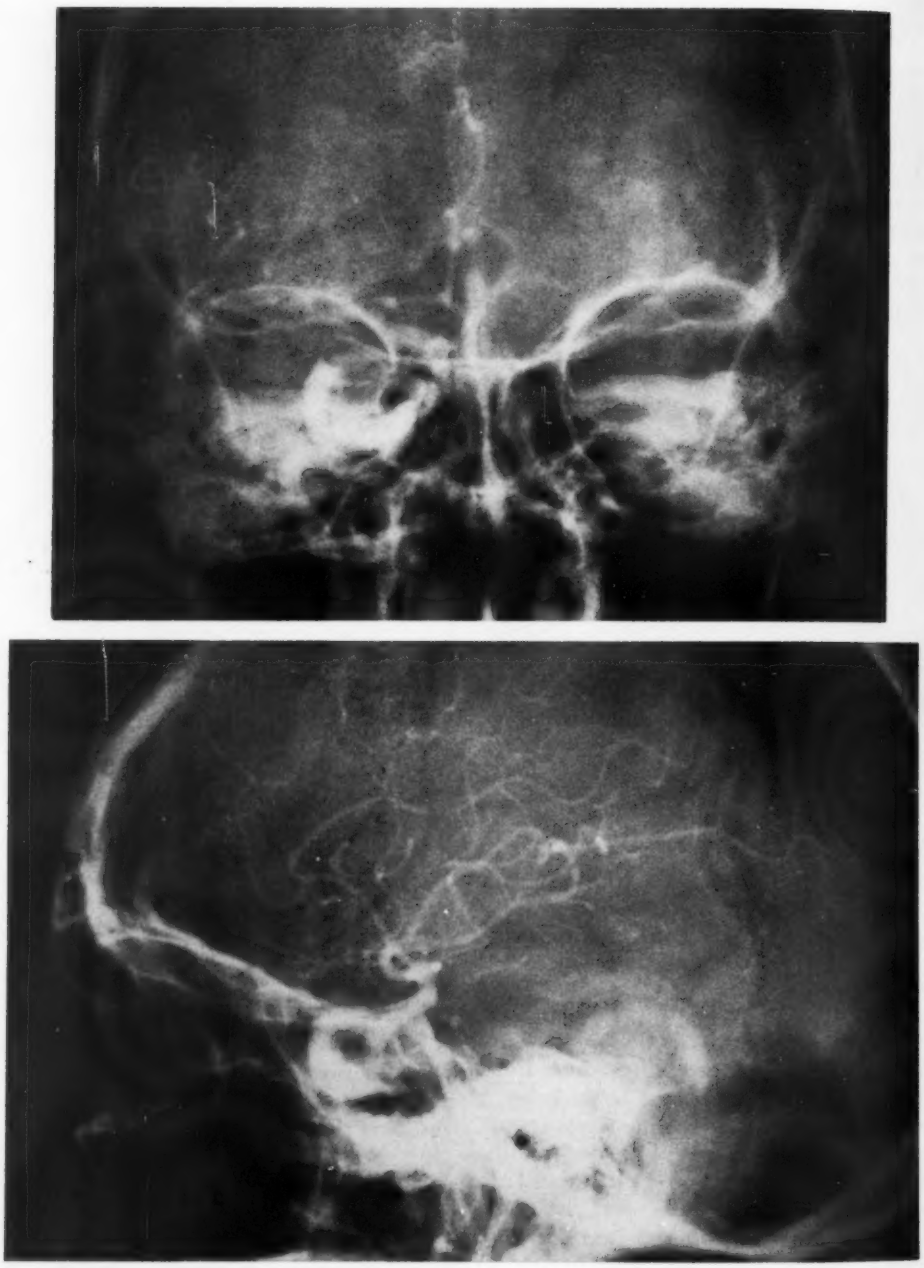

Fig. 2. Frontal and lateral arteriograms showing large ophthalmic artery aneurysm with filling defect representing a thrombus. Note the abrupt crescentic termination at the optic foramen in the frontal projection.

left. Funduscopically there were marked pallor of the temporal portion of the optic disk and normal coloration of the nasal portion. The right disk could not be visualized because of lenticular opacity. The extraocular movements were unimpaired. There was some puffiness of the left lid as compared

with the right. No pulsations nor bruits were elicited on auscultation of the skull or eyeballs. Both pupils reacted to light and the left to accommodation. There was no nystagmus. Heart and lungs were normal. Pulse, temperature, and respirations were normal. Blood pressure 150/80.

Neurologic examination revealed normal reflexes and muscle tone. There were no sensory changes.

A blood count was as follows: hemoglobin 12 gm.; red cells 4,000,000; white cells 8,600 with a normal differential count. The urine showed specific gravity of 1.020, no albumin or sugar, and a trace of acetone. Urinary sediment was normal.

The routine skull films presented no abnormal findings. Studies of the optic foramina revealed extensive erosion on the left (Fig. 1). This suggested an expanding lesion, and carotid angiography disclosed a large aneurysm of the left ophthalmic artery ending abruptly in a crescentic fashion at the optic foramen. There was also a filling defect which at operation proved to represent a thrombus within the aneurysm (Fig. 2). The right optic foramen and right carotid angiograms were normal, the visualized right ophthalmic artery being of normal course and caliber (Fig. 3).

Through a left transfrontal approach, the orbit was unroofed, disclosing a pulsating aneurysm 4 cm. in diameter, which had wedged and thinned the left optic nerve by direct compression. The aneurysm arose from the left internal carotid artery by a short aneurysmal stalk which did not allow for the placement of a ligature. Within the aneurysm was a thrombus. Two days later the left internal carotid artery was ligated. The pulsation of the left globe which had occurred following the initial unroofing of the orbit now disappeared. The patient was able to detect light to a slight degree through the left eye.

## DISCUSSION

The two significant structures which pass through the optic foramen are the optic nerve and the ophthalmic artery. The optic nerve lies in the upper inner aspect of the foramen, whereas the ophthalmic artery lies in the lower outer aspect (2). With these anatomic relationships in mind, the films of the optic foramina were reviewed, and it was noted that the inner aspect of the foramen, corresponding to the location of the optic nerve, was intact. The erosion, although extensive, did in fact involve the outer portion of the foramen, which corresponds in location to the ophthalmic artery. It would seem, therefore, that an expanding lesion of the ophthalmic artery, *i.e.*, an aneurysm, might have been inferred as the diagnosis from the position of the erosion and the fact that the inner portion of the foramen related to the optic nerve was intact.

Fig. 3. Normal right optic foramen.

## SUMMARY

1. A case report of an ophthalmic artery aneurysm eroding the outer wall of the optic foramen is presented. The aneurysm was demonstrated preoperatively by angiography.

2. The possibility of diagnosing the aneurysm from the plain films on the basis of the anatomic relationships of the optic nerve and ophthalmic artery within the optic foramen is discussed.

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SUMMARIO IN INTERLINGUA

**Aneurysma del Arteria Ophthalmic**

Es reportate un caso de aneurysma del arteria ophthalmic erodente le pariete exterior del foramine optic sinistre. Le erosion esseva demonstrate in un roentgenogramma simple. Su apparentia suggereva le presentia de un lesion expansori. Angiographia carotic revelava un grande aneurysma, con un defecto de plenation que se revelava al operation como resultato de un thrombo intra le aneurysma. Le reexamine del pelliculas simple monstrava que le erosion esseva restringite al pariete exterior del foramine, correspondente al location del arteria ophthalmic, durante que le portion interior del foramine esseva intacte, correspondente al location del nervo optic. Isto, il pareva in retrospecto, haberea potite suggerer le diagnose.

# Angiographic Demonstration of the Primitive Trigeminal Artery (Carotid-Basilar Anastomosis)[1]

BURTON L. WISE, Capt., M.C., USAR

THE PRIMITIVE trigeminal arteries appear in the 3-mm. human embryo, connecting the internal carotid arteries with the paired longitudinal arteries which eventually fuse to form the basilar artery (4). After the formation of the posterior communicating arteries, at the 14-mm. stage, the trigeminal arteries regress as a rule. Rarely, they persist in the adult.

Reports of postmortem demonstration of persistent carotid-basilar anastomoses were reviewed by Sunderland (7, 8), who found 3 examples of this anomaly in 210 brains examined. In 2 instances, the vessel accompanied the trigeminal nerve in Meckel's cave; in the third it coursed through a separate foramen to reach the cavernous sinus, where it joined the carotid artery.

Recognition of this congenital anomaly in cerebral angiograms has been reported by Sutton (9), Sugar (cited by Harrison and Luttrell, 2), Harrison and Luttrell (2) (3 cases), Murtagh et al. (3), Schaerer (6) and Poblete and Asenjo (5) (2 cases).

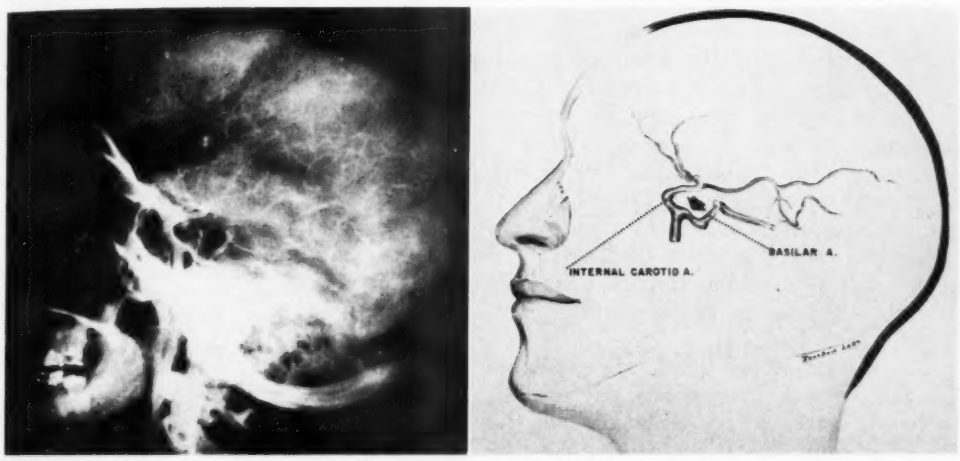


Fig. 1. Lateral view of right carotid angiogram (retouched) demonstrating primitive trigeminal artery (carotid-basilar anastomosis) and artist's drawing of same. Arrow points to trigeminal artery.

## CASE REPORT

A 29-year-old white female was admitted to Letterman Army Hospital, Dec. 14, 1955. In 1950, the patient began to drink heavily, averaging about a pint of rum daily during the two years prior to admission. About four months before admission, she began to have episodes of automatic behavior, with amnesia, lasting fifteen to thirty minutes. Episodes of rage also occurred, in which she would throw any object within reach. There was a history of occasional severe bifrontal headaches since childhood, which had recently shown a gradual decrease in frequency. Minor head injuries had occurred at the ages of three and eighteen years.

Except for a small capillary angioma in the left temporal scalp area, no abnormalities were noted on physical examination. Neurological examination was within the limits of normal, as were a complete blood count, urinalysis, and spinal fluid examination.

An electroencephalogram on Dec. 23, 1955, with the patient awake, was within normal limits. Repeat electroencephalograms on Jan. 4 and 12, 1956, with the patient asleep, demonstrated slowing and

[1] From the Neurosurgical Service, Letterman Army Hospital, San Francisco, Calif. Accepted for publication in October 1956.

sharp waves in the right parietal and occipital areas.

A pneumoencephalogram was within the limits of normal. Right carotid angiography, performed by the percutaneous technic, under local anesthesia, revealed a large vascular channel joining the proximal subclinoid portion of the internal carotid artery with the midportion of the basilar artery (Fig. 1). The portion of the basilar artery distal to this channel and both posterior cerebral arteries were well filled with the medium. No other abnormalities were noted.

Therapy with Dilantin, 100 mg., and phenobarbital, 32 mg., each three times daily, was instituted. The patient remained free of seizures up to the time of writing.

## DISCUSSION

It appears that a persistent trigeminal artery does not, *per se*, have any pathological significance. To our knowledge, there are *no* reports of this anomaly causing trigeminal neuralgia (because of its location adjacent to the trigeminal nerve) or any other signs or symptoms. There has been one instance of an aneurysm arising from this vessel (1); 2 patients had associated aneurysms of the middle cerebral artery (3, 6) while 1 had an associated carotid aneurysm (5).

The basilar artery usually is small below the point of anastomosis, one or both vertebral arteries may be small, and the posterior communicating arteries may be small or absent (2, 6, 8, 9).

The frequency of this anomaly has been variously reported as 3 in 210 brain specimens (8), 1 in nearly 1,000 arteriograms (9), 3 in 582 arteriograms (2), 1 in nearly 600 arteriograms (6), and 2 in 828 arteriograms (5).

The present case was the only one noted in 397 cerebral arteriograms recorded at this hospital.

## SUMMARY

Persistent trigeminal artery (carotid-basilar anastomosis) is a rare congenital cerebral vascular anomaly, probably without pathological significance. A case is reported in which this anomaly was demonstrated angiographically.

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## SUMMARIO IN INTERLINGUA

### Demonstration Angiographic del Primitive Arteria Trigeminal (Anastomose Carotico-Basilar)

Le primitive arterias trigeminal appare in le embryon human al stadio de 3 mm. Normalmente illos regrede post le formation del arterias communicante posterior, i.e. al stadio de 14 mm. Le persistentia del arteria trigeminal (anastomose carotico-basilar) al etate adulte es rar e probabilemente sin signification pathologic.

Es reportate un caso in que iste anormalitate vascular esseva discoperite in le curso del examine cerebro-angiographic de un femina de vinti-nove annos de etate admittite al hospital a causa de problemas comportamental. Isto esseva le sol tal exemplo inter 397 studios de angiographia cerebral executate al hospital in question. Un grande canal vascular esseva demonstrate que anastomosava le portion subclinoide proximal del arteria carotic interne con le mesoportion del arteria basilar. Nulle altere anormalitates esseva observate.

# Dark Adaptation with Limited Light and Color Vision[1]

FREDERIC N. SILVERMAN, M.D.,[2] and JEROME COHEN, Ph.D.[3]

DARK ADAPTATION is a prerequisite for many activities which must be carried out in subdued light. In the field of roentgenology, it has long been recognized as a necessity for satisfactory fluoroscopic examination. For this reason, radiologists customarily cover their eyes with various types of light-restricting shades for periods varying from ten to thirty minutes prior to undertaking the procedure.

The most common form of dark-adaptation glasses in use at the present time is a shielded face-fitting goggle with a red plastic filter. This permits light of the longer wave lengths to pass, but effectively restricts the wave lengths below 600 millimicrons, which would desensitize the receptors for low illumination if transmitted to the retina. Moreover, it serves to decrease the total intensity of light of all wave lengths entering the eyes.

During the period of dark adaptation or accommodation, the radiologist is strictly limited in the use of his time; he cannot examine films and properly does not give any opinion concerning them; neither can he see color. The loss of acuity of vision and the inability to recognize differences in wave lengths (color) are extremely disadvantageous, as they prevent recognition of cyanosis, blood in vomitus, stools, urine, etc., and skin lesions, particularly those of an erythematous nature, which may be important in overall diagnosis. Generally, the radiologist uses accommodation time for handling of correspondence or other administrative activities but even here he is handicapped by the lack of color vision. Marginal notations in a red pencil, for example, are completely invisible while red adapting glasses of the usual variety are worn.

In November 1955, Doctor William A. Faraghan described a modification of glasses for dark adaptation in a Letter to the Editor of RADIOLOGY (1). Doctor Faraghan noted an initial inequality of dark adaptation of the right and left eyes when fluoroscopy was preceded by covering one eye with a head mirror for performance of bronchography. The eye covered by the reflecting mirror was consistently better adapted than the other. This was interpreted to mean that the tubular vision provided by the central aperture of the head mirror resulted in some degree of dark adaptation even though the procedure had been carried out in a brightly lighted room. To test this possibility, Dr. Faraghan removed the red filter from a pair of standard goggles and replaced it with opaque cardboard having a black inner surface; two holes, 8 mm. in diameter (approximately equal to half that of a head mirror), were cut in the cardboard to center over the pupil of each eye. The frames held the clear apertures approximately 2.5 cm. in front of the eye, producing a partial collimating effect.

With this modification, adequate adaptation was achieved under conditions of normal illumination and even during inspection of banks of viewing boxes. Moreover, adaptation was not lost if fluoroscopy was interrupted for examination of spot-films through the goggles. Many procedures requiring subsequent or intermittent fluoroscopy, as bronchography, myelography, etc., could be done, without requiring a delay for accommodation, while wearing the opaque goggles with the 8-mm. apertures. The one objection was that the tubular vision made movements uncertain, and collisions with other people or with pieces of apparatus were likely to occur.

The advantages of color and white-light

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vision during preparation for fluoroscopy or in the course of its performance were so appealing that we immediately repeated Doctor Faraghan's experiment. Subjectively, we could confirm his claims, including those with respect to the difficulties of walking around the department while wearing opaque glasses. This problem we sought to overcome by making apertures in the red filters rather than in opaque cardboard. In this way, we achieved central acute and color vision as well as peripheral vision through the red filter. Also, we decided to study the effect of openings of different sizes and shapes to obtain some sort of objective evaluation of the relative efficiency of perforated filters in comparison with standard solid-color filters of dark-adaptation glasses.

## THEORETICAL CONSIDERATIONS

A brief review of the physiology of dark adaptation indicates that Doctor Faraghan's idea is based on well established facts. The fovea centralis of the macula lutea, which is concerned with central vision of greatest acuity, is composed exclusively of cones; the cones are the receptors for color vision with a brightness level of about 1 millilambert or more. Elsewhere in the retina there are mixtures of rods and cones except in the extreme periphery, where cones are entirely lacking. The rods respond to light of low intensity, levels of less than 1 millilambert, and cannot distinguish colors with the same degree of sensitivity to low brightness levels as the cones. With the collimation of bright light, so that it falls only on the region of the macula lutea, the dark adaptation of the rods should be relatively unaffected, except for minor effects of retinal induction and light scatter within the eye.

The macula lutea subtends an angle of approximately 5° and is 1 to 2 mm. in diameter; therefore, an opening in the filter allowing a beam of light to fall on the retina which does not exceed this measurement is desirable. The standard goggles hold the filter approximately 2.5 cm. in front of the cornea. The clear aperture is therefore 2.5 cm. in front of the refractive system of the eye. As the eye is approximately 2.25 cm. in depth, the diameter of the area subtended on the retina is only about 10 per cent less than that of the aperture. An opening approximating 2 mm. would thus be the most efficient, theoretically.

From the practical standpoint, it is necessary to remember that the eye moves and the spot of white light must fall on areas other than the macula. This would tend to handicap dark adaptation, the handicap becoming greater as the aperture is enlarged. Anticipating some reciprocal relationship between the size of the opening and the degree of dark adaptation, the smallest area consistent with comfort should be sought.

In so far as shape is concerned, a circular aperture would seem to correspond best to the relative shape of the macula lutea. People vary appreciably, however, in their interpupillary distances. Each person would therefore have to have apertures made in his glasses to correspond to his own interpupillary distance and the glasses could not be used by anyone whose eyes were set wider apart or closer together.

The Eskimos have used a horizontal slit in a piece of bone as a sunglass against the brilliant white light of the arctic areas. Horizontal eye movements predominate in reading, and slits allow the head to remain stationary, while holes require that it be moved in order for the eyes to traverse a line of print. In addition, a slit would permit greater latitude in the use of glasses by different individuals, inasmuch as 2 slits, each 2 mm. high and 1 cm. in width, separated at their medial extremities by 55 mm., would be satisfactory for distant vision for interpupillary distances from 55 to 75 mm. (the distances between the medial and lateral extremities of the slits). Persons with interpupillary distances above 60 mm. would have no trouble in using such glasses for convergent vision, although those in whom the distance lay between 55 and 60 mm. might experience some difficulty. Interpupillary distances from 55 to

75 mm. would probably include the majority of normal individuals.

Multiple small holes, as used in opaque glasses following removal of cataract, produce too broken a field for visualization of detail in films, and therefore were not considered suitable for investigation.

## THE EXPERIMENT

The following experiment was devised in order to test the degree of dark adaptation obtained with several types of openings in colored glasses in comparison with standard solid-filter glasses and with none at all. One pair of standard dark-adapter goggles was modified by cutting two 2×10-mm. horizontal apertures in front of each eyepiece. A second pair had 4-mm. circular openings in front of each eye. A third pair had a 4-mm. aperture in front of one eye only. A fourth pair was made opaque with a 4-mm. central hole cut in front of each eye. These will be referred to, respectively, as slit glasses, two-hole glasses, one-hole glasses, and opaque glasses.

*Procedure for Measuring Dark Adaptation:* The subject sat in a completely dark room with his head in a Bausch and Lomb head-holder and his eyes 12 inches from a ground-glass circular screen, 6 inches in diameter, directly in front of him. Below this viewing screen was a white cardboard, 24 × 24 inches, tilted to be perpendicular to the line of sight. The white cardboard was illuminated by two 100-watt bulbs, in reflectors placed under the chin of the subject, to a brightness of 520 millilamberts. A cross was drawn in the center of the cardboard to act as the fixation point for the pre-exposure light field.

The ground-glass dark-adaptation field was illuminated from the rear by an enclosed projector with a 7-watt bulb replacing the projector lamp. The beam was directed through a closed polaroid filter and illuminated the screen with a greenish cast, similar in appearance to the fluoroscopic screen. The brightness of the viewing screen was controlled by varying the current to the bulb by a voltage regulator. The voltage, however, was kept within the middle range so the color and brightness of the light source remained about the same. A movable pointer, 3/8 inch wide, extending from the circumference of the circle 1 1/2 inches toward its center, cast a shadow on the ground-glass screen. The subject was to report in what clock position he saw the pointer, as soon as he could be sure of its position.

Two psychologists and two laboratory assistants who had had experience as subjects in perceptual experiments were used for the tests. All had normal or normally corrected acuity, and none had known night-vision deficiency. No attempt was made to measure brightness thresholds, but a discrimination judgment was chosen as a test of greater validity for comparison with fluoroscopy. There are marked individual differences in dark-adaptation functions and, although each subject was his own control in this experiment, the following method was used to make the different scores comparable. For each subject a brightness level was chosen that required about a minute for adaptation to the criterion level with the standard dark-adapter goggles in preliminary trials. The screen brightness was always below 0.001 millilamberts, but we are not able to state precisely what the values were.

In the experiment proper, each of the glasses was worn for a series of ten dark-adaptation trials, and the different goggles were presented in random order to each of the four subjects. The "no-glasses condition" was tested only five times per subject, because it was so time-consuming.

Before any of the series, the subjects wore the goggles to be tested for ten minutes indoors, then spent three minutes in the dark before the first trial, still wearing the glasses. This pre-exposure time (13 minutes) was selected since it was sufficiently long to light-adapt the subjects between the dark-adaptation trials. The trial consisted of fixating the light-adapting bright field for a minute and a half. The illumination of the bright field was then turned off, the subject removed the goggles and looked anywhere within the circular

TABLE I: AVERAGE DARK ADAPTATION TIME TO REACH CRITERION OF SEEING FOR EACH SUBJECT

| Subject | Voltage regulator setting | Goggles | | | | | |
|---|---|---|---|---|---|---|---|
| | | None | Red | Slits | Two-hole | One-hole | Opaque |
| A. | 50 | 803* | 97 | 98 | 128 | 107 | 128 |
| L. | 40 | 596 | 102 | 121 | 149 | 89 | 91 |
| B. | 45 | 385 | 91 | 160 | 154 | 73 | 92 |
| J. | 40 | 927 | 113 | 182 | 139 | 127 | 95 |
| Mean | | 677 | 101 | 140 | 143 | 99 | 101 |
| Per cent saved | | | 85 | 79 | 79 | 85 | 85 |

* Entries are in hundredths of a minute.

field until he could report the position of the pointer. The interval between the removal of the bright field and the discrimination of the pointer setting was measured in hundredths of a minute. The position of the pointer was varied at random from trial to trial. Extreme peripheral vision was ruled out by requiring the subject to fixate within the boundaries of the circle. Since the parafovea is more sensitive to dim illumination than is the fovea, the subjects were instructed to look at the opposite edge of the circle rather than directly at the pointer when they thought they saw the latter in a particular position.

## RESULTS

Table I presents the mean adaptation time required by the four subjects, using the different goggles, and no goggles, to attain the same criterion of seeing. To reach the selected criterion without goggles the average was 6.77 minutes. With standard red goggles the average was 1.01 minutes, which represents a saving of 5.76 minutes.

The ratio of the time saved with a given type of goggles to the total time necessary for adaptation without goggles may be expressed as a percentage. For example, if it takes a person five minutes to reach the criterion level of dark adaptation without goggles and, by pre-adapting with goggles, he saves four minutes out of five, or 80 per cent of the adaptation time, then it can be said that the goggles are 80 per cent effective.

The average time saved with the solid red goggles for our four subjects, was 85 per cent. The average saving with the goggles with one 4-mm. hole in front of one eye and with the opaque glasses with a 4-mm. hole in front of each eye, was also 85 per cent. Thus, on the average, subjects performed just as well with the opaque and the one-hole goggles as they did with the solid red goggles. It can be seen from the table that the glasses with the two 4-mm. holes and with the 2 × 10-mm. slits in front of each eye, requiring an average of 1.4 minutes for vision under conditions of the test, were less effective than the one-hole and the opaque goggles. The two-hole and two-slit goggles were 79 per cent effective, as compared to the 85 per cent effectiveness of the others.

Since the dark-adaptation function is not linear with time, the percentages have little generality, but the obtained order of effectiveness should hold for the conditions encountered in fluoroscopy. We cannot say what the savings in dark-adaptation time would be if it took as short as three or as long as twelve minutes to dark-adapt with no goggles.

The Wilcoxon "T" test for paired replicates, based on pairs of rankings, showed no statistical differences between the one-hole, the opaque, and the red spectacles for all the subjects. With the two-hole goggles all four subjects took significantly longer to reach the criterion of seeing than with the red goggles. This was significant at the 1 per cent level of confidence. For three of the four subjects, the slit glasses took significantly longer, at the 1 per cent level of confidence, than the red goggles.

Statistically it can be concluded that the two-hole and the slit goggles are significantly poorer than the solid red goggles,

while the one-hole and opaque glasses show no significant difference.

## DISCUSSION

Central color vision and higher-brightness vision for such activities as reading, clinical examinations, and viewing x-ray films are gained with apertures in dark-adaptation goggles. It is an advantage to have full central color vision so long as there is little expense in terms of effectiveness of vision during dark adaptation.

It is not intended to imply by these results that high-intensity white light, permitted to enter the eye during the course of dark adaptation with red goggles, will not affect the dark adaptation. Obviously, the level of adaptation is related to the amount of light entering the eye. If we are dealing with minimal detectability or minimal discriminability of light at very low intensities, then exposing the eye to high-intensity white light will have deleterious consequences for dark-adaptation time. It is felt, however, that the criterion of seeing used in this experiment is valid in terms of fluoroscopy, where brightness discriminations of small detail are made at about the same brightness level as was used in this study.

Each of the subjects in the experiment was fitted with two-hole goggles, corresponding to his interpupillary distance, but all wore the same pair of slit glasses since there was enough overlapping of the field to serve both eyes. The two-hole and the slit goggles are somewhat less effective than the solid red spectacles in terms of adaptation time. Moreover, the two-hole goggles have to have the proper interpupillary separation in order to avoid disturbing double images of the holes with overlapping boundaries. If the apertures fit both eyes for reading distances, then the boundary edges become annoying when converging for more distant objects. With increased convergence for near vision, the proper interpupillary separation for distant objects is incorrect.

The opaque goggles are poor in terms of visual efficiency because of the loss of peripheral vision, making it impossible to move around comfortably. A full visual field at the expense of greater adaptation time seems greatly preferable to central color vision and acuity at the expense of loss of the visual field. The opaque glasses, therefore, do not seem desirable in the practical situation.

The most favorable and comfortable goggles are those with a hole in front of one eye. The boundary of the hole is much less noticeable than with two holes. The total field is presented and there is full color vision. At the high brightness levels at which the glasses are worn, one-eye acuity should be sufficient. Perhaps the one hole should be placed over the nondominant eye, or the eye with lower acuity, so that the more sensitive or high-acuity eye would be at a better dark-adaptation level for fluoroscopy. There is no need for concern over the interpupillary distance because small changes in head position will make possible convergence for any distance, while the hole still remains in central position. This type of goggle has been worn by one of us (F.N.S.) since the initial phases of this study and has proved so satisfactory that standard glasses would not be used again by choice.

On the basis of our observations, we would recommend that an aperture be cut in front of one eye only and that it be a slit. Since the two-hole goggles are no more effective than the two-slit goggles, a single slit would surely be as effective as a single hole. The slit should be cut horizontally and should not be greater than $2 \times 10$ mm. The slit has the advantage over the hole that it allows more freedom of eye movement, which is desirable for reading. With the slit, also, a pair of glasses will fit people with different interpupillary distances, whereas the hole requires more accurate placement in front of the eye, depending on the individual interpupillary distance.

In either instance, it may be desirable to fill in the apertures with clear colorless plastic. One of the members of the Radiology Department complained of an

irritating air current coming through the hole when walking; this feature was not appreciated by those who habitually wear glasses under the goggles.

Increasing use of image intensifiers may limit the need for dark adaptation prior to fluoroscopy, but for the present most radiologists must contend with the traditional equipment. The cutting of an opening as described would not adversely affect the dark adaptation and there would be a great gain from the ability to have central bright and color vision for reading, examining films, and many other activities.

## SUMMARY

An objective evaluation was made of the effectiveness of cutting apertures of various sizes and shapes in dark adaptation goggles in promoting dark adaptation. Goggles with a 4-mm. circular aperture in front of one eye only were as effective as standard, non-perforated red filter goggles; opaque goggles with a 4-mm. circular aperture in front of each eye were equally effective, but the loss of peripheral vision was undesirable. Standard red filter goggles with an opening 4 mm. in diameter in front of each eye were appreciably less effective. A horizontal slit, 2 × 10 mm., in front of each eye, permitted horizontal movements and greater latitude in fitting the goggles, which were as effective as the two-hole goggles.

The evaluation agrees with subjective experience that a small aperture in front of one eye permits satisfactory dark adaptation for fluoroscopy, and also allows color vision and acuity of vision. The radiologist is thus afforded an opportunity for activities previously denied him while accommodating for fluoroscopy. On theoretical grounds, a 2 × 10-mm. horizontal slit in front of one eye is recommended.

ACKNOWLEDGMENT: The authors acknowledge the advice and assistance given by Doctor Donald J. Lyle, Professor of Ophthalmology, College of Medicine, University of Cincinnati.

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## SUMMARIO IN INTERLINGUA

### Adaptation al Obscuritate con Lumine Limitate e Vision de Color

Esseva facite un evalutation objective del efficacia de effectuar aperturas de varie dimensiones e conformationes in lunettas de adaptation al obscuritate con le objectivo de promover le adaptation al obscuritate. Lunettas con un apertura circular de 4 mm ante solmente un del oculos esseva tanto efficace como non-perforate lunettas standard a filtro de rubio. Lunettas opac con aperturas circular de 4 mm ante ambe oculos esseva equalmente efficace, sed le resultante perdita de vision peripheric esseva indesirabile. Lunettas standard a filtro de rubio con un apertura de 4 mm de diametro ante cata oculo esseva appreciabilemente minus efficace. Un fissura horizontal de 2 x 10 mm ante cata oculo permitteva movimentos horizontal del oculos e un plus grande latitude in adjustar le lunettas. Illos esseva tanto efficace como lunettas a duo aperturas.

Le resultatos de iste studio es de accordo con le experientia subjective que un parve apertura ante un oculo permitte grados satisfactori de adaptation al obscuritate pro le objectivos del fluoroscopia e que illo etiam permitte vision de color e acuitate visual. Super le base de consideratione theoric, un fissura horizontal de 2 × 10 mm ante un del oculos es recommendate.

# EDITORIAL

## The Lymph Node-Fever Relationship in Lymphoma

Not infrequently in the practice of radiology certain patients with lymphomatous disease are encountered in whom temperature fluctuations seem to coincide with periods of enlargement or regression in size of the spleen and lymph nodes. In a fair number of these persons irradiation of the node masses, particularly in the mediastinum or retroperitoneal region, seems to bring about a prompt drop in temperature toward normal levels. It seems natural, therefore, that speculation should arise over a possible direct influence upon body temperature of some unknown factor in the lymphatic system.

Most authorities agree that all fever is the result of dysfunction of the hypothalamic heat-regulating centers, which may be brought about through the direct effect of any of several different irritants, toxins, or pyretic agents. In the presence of inflammation, intoxication, or malignant degeneration, living cells may be injured and liberate endogenous biochemical factors of this sort to initiate a rise in temperature. From the polymorphonuclear leukocytes of rabbits such a pyrogen has been extracted, which is known to cause abnormal behavior of white cells *in vitro* and to produce fever *in vivo*. If, however, daily injections of this agent are given, the cells cease to behave abnormally *in vitro*, and fever does not develop. This "tolerance" depends upon a normally functioning reticulo-endothelial system, and it may be that in tolerant individuals the pyrogen is being removed by phagocytosis.

Besides these pyrogens, numerous other factors have been proposed as possible agencies for fever production in lymphomatous disease, and as possibly being related to fluctuations in the size of the nodes and spleen. One by one, many of these facets of the lymphoma problem have been clarified, and the process of elimination is steadily narrowing the area of mystery surrounding the fever and node enlargement relationship.

Plasma protein abnormalities have been given much attention; but these have been shown to be non-specific changes, indicating only systemic intoxication and debility. In most cases of Hodgkin's disease electrophoretic studies show lowering of serum albumin and elevation of certain globulin constituents, with reversion toward normal whenever the disease can be effectively controlled. Patients with Hodgkin's disease in whom lymph nodes and spleen fluctuate in size show no significant serum protein abnormalities. The effect of therapeutic irradiation on serum proteins is still under study. In multiple myeloma, the abnormal serum components have not been affected by irradiation.

The relation of infection and necrosis to changes in the size of lymph nodes and spleen in lymphoma has also been studied at length. Several observations, however, seem to refute the possibility of a direct connection. Since as early as 1911 there have appeared in the literature well documented cases of Hodgkin's disease in which spontaneous regression of enlarged lymph nodes and spleen have occurred simultaneously with fever remissions. By attributing the decrease in node size to the elimination of secondary infection, it is implied that such nodes may not have been involved by the lymphomatous process. Biopsy, however, has shown the presence of Hodgkin's disease in these very nodes before the size decrease occurred,

without evidence of infection. If a local infection were the cause, it is unlikely that several node groups would regress, as has so often been the case. The infrequent involvement in Hodgkin's disease of tonsillar and superior cervical nodes, usually prime sites for infection, also casts doubt upon the possibility of infection causing the enlargement in lymphoma. One author (9) has pointed out, not unwisely, that temperature drop, decrease in the size of nodes, and spleen shrinkage are not likely to be based upon necrosis, as they coincide with apparent restoration to normal health, whereas patients with necrotic neoplasms are usually ill.

The study of virus infection in lymphoma has centered largely around Hodgkin's disease. Many of the virus-like particles earlier described have later proved to be artifacts in the electron microscope preparations. In certain cases of mouse leukemia, however, real viruses have been isolated which transmit the disease to newborn mice in some instances and to adult hosts as well in others. There is no substantial evidence at present that viruses play any etiologic role in Hodgkin's disease. Nevertheless, warts and papillomas are transmissible by filtered extracts in man, and it is quite possible that many other human neoplasms may be of viral origin.

The frequent association of Hodgkin's disease with tuberculosis, brucellosis and *Cryptococcus neoformans* infections, and with reduced tuberculin reactions in many patients, suggests a defect in immunity in Hodgkin's disease but, although that disease widely affects the reticulo-endothelial system, humoral antibodies apparently continue to be produced normally. The defect consists principally in a loss of skin reactivity, and thus is a limited one, unrelated to complement levels, capability of tissues to respond, or to production of circulating antibody. Failure of antibody production is probably a non-specific occurrence, as it is also observed in indolent infections such as syphilis, brucellosis, and in the post-typhoid state. At any rate, it is unlikely that either viruses or the immunity mechanism play any important direct role in the production of fever or node enlargement.

It is possible, even likely, that the lymph node-fever relationship may be valid only within certain diseases or stages on the lymphoma scale, which may explain why all patients do not respond to treatment in the same way. The concept presented by Carter (2) lends itself well to an understanding of this proposition. According to this concept, primitive reticulo-endothelial cells, the parents of all blood cells, may divide into daughter cells of two types. One group, made up of undifferentiated cells, forever perpetuates itself in the form of immature cells, repeatedly divides into young forms, and never takes part in maturation or development. The second group shows more differentiation and evolves through a cycle of maturation into leukopoietic cells and ultimately into mature white blood cells. At any stage of the maturation cycle an arrest in differentiation may occur, and the arrested cells continue then to divide at either a normal or an increased rate. The mature white cells are not capable of mitotic division, and so decrease in number while the immature cells increase. The stage of maturation at which arrest has occurred, the percentage of immature cells arrested, and the rate of proliferation at the arrested stage, will determine the clinical and histologic subdivision under which the disease is then classified on the lymphoma scale.

Multiplying cells, if proliferating rapidly enough, may outstrip their own blood supply and begin to undergo involution. This is presumed to give rise to the formation of pyrogenic substances. In certain cases of lymphomatous disease, the differentiating mitotics evidently multiply and degenerate in just this manner. What it is that occurs when they are exposed to ionizing radiation to bring about a temperature drop is a matter of speculation.

Several known effects which irradiation brings about in normal tissues probably are at work. Irradiation produces an

almost immediate drop in the peripheral lymphocyte count, which can be demonstrated in the first few minutes after exposure. Within an hour, degeneration of lymphocytic nuclei and breaking up of germinal centers can be seen. During the next five days lymphocytic destruction progresses, and macrophages appear in great numbers, devouring nuclear fragments and red cells. Cell reproduction is temporarily inhibited, and mitoses are absent for a few days. Later they again become abundant. Irradiation also causes the formation of histamine-like substances, which by direct effect upon capillary walls produces dilatation of capillary loops, hyperemia, and erythema.

Following irradiation in lymphoma, there probably is early reduction in the number of differentiating mitotic cells, similar to the initial lymphocytopenia described above, and a corresponding drop in the output of endogenous pyrogens. Increased numbers of circulating macrophages may further reduce the amount of the pyrogenic substances or their effect. Improved tissue vascularity also probably plays a part by retarding the process of cell involution. The overall effect seems basically to be one of diminution in the amount of circulating pyrogens, and temperature reduction therefore does not seem surprising.

It is unlikely that there are any specific factors at work in the retroperitoneal or mediastinal areas which are not present at other sites of lymphoid tissue aggregation. However, irradiation through those areas for the relief of fever in lymphoma may not be completely irrational.

The lumbar, periaortic, mesenteric, and peripancreatic lymph nodes are very numerous, making up approximately half of all the lymph nodes in the body. Any widespread disease of the lymphatic system is consequently not unlikely to be affected by judicious trial irradiation through a fairly wide mid-abdominal portal. Similarly, if the mediastinal lymph nodes are grossly enlarged beyond normal in lymphoma, one might reasonably hope to observe reduction of fever after irradiation of that region.

Present knowledge seems to warrant the presumption that a real lymph node-fever relationship does exist in many lymphoma patients. It is probably safe and reasonable to direct our therapeutic efforts in the management of these patients accordingly.

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### KANSAS RADIOLOGICAL SOCIETY

At the recent annual meeting of the Kansas Radiological Society, the following officers were elected: President, G. Sherman Ripley, Jr., M.D., of Salina; Vice-President, Lewis G. Allen, M.D., Kansas City; Secretary, James R. Stark, M.D., 3244 East Douglas St., Wichita. Dr. Charles M. White of Wichita was chosen Councilor to the American College of Radiology, and Dr. A. M. Cherner of Hays, Alternate Councilor.

### KENTUCKY RADIOLOGICAL SOCIETY

New officers of the Kentucky Radiological Society are Dr. David N. Shapiro, Louisville, President; Dr. James S. Rich, Lexington, Vice-President; Dr. Robert H. Akers, 1405 West Broadway, Louisville 3, Secretary-Treasurer.

### CANADIAN ASSOCIATION OF RADIOLOGISTS

At The Twentieth Annual Meeting of the Canadian Association of Radiologists, the following were elected to office for the current year: Dr. Jean Bouchard, President; Dr. A. R. McGee, Vice-President; Dr. Guillaume Gill, Honorary Secretary-Treasurer; Dr. Robert G. Fraser, Associate Honorary Secretary-Treasurer.

### SOCIEDAD DE RADIOLOGIA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY

The Uruguayan Society of Radiology, Cancer Research, and Physical Medicine has announced the following list of officers: President, Professor Dr. Rodolfo Tiscornia; Vice-President, Dr. Raul Leborgne; Secretary General, Dr. Ricardo Parada; Recording Secretary, Dr. Roberto François; Treasurer, Dr. Enrique Capendegui; "Vocals," Professor Dr. Leandro Zubiaurre and Dr. Carlos Sturzenegger.

### BIOPHYSICAL SOCIETY

At the recent National Biophysical Conference in Columbus, Ohio, a Biophysical Society was formed. Radiologists may be interested in this new organization as a source of information on biophysicists available for departments of radiology. For further information address Dr. Lee B. Lusted, Diagnostic X-ray Department, The Clinical Center, National Institutes of Health, Bethesda 14, Md.

### HICKEY MEMORIAL LECTURE

The annual Hickey Memorial Lecture was delivered in Detroit, Mich., under the joint sponsorship of the Wayne County Medical Society, the College of Medicine of the Wayne State University, and the Detroit Roentgen Ray and Radium Society, on March 14, 1957. Dr. John Caffey of New York spoke on "The Skeleton in Cooley's Anemia."

On this occasion, a portrait of Dr. Lawrence Reynolds, Editor of the *American Journal of Roentgenology*, painted by John S. Coppin, was unveiled and was presented to Dr. Reynolds by his former residents in "deep appreciation for his splendid teaching and guidance in the practice of the science of radiology."

### FELLOWSHIPS IN RADIOLOGICAL PHYSICS

The Oak Ridge Institute of Nuclear Studies has announced the award of 84 one-year fellowships in radiological physics to train a new group of college graduates from thirty-one states in the field of study, evaluation, and control of the potential hazards of ionizing radiations. The Institute administers the fellowship program for the U. S. Atomic Energy Commission.

Each fellow will spend the nine months of the 1957–58 scholastic year at an assigned university, supplementing his academic courses with three months of actual experience at one of three Commission laboratories. The cooperating institutions are Vanderbilt University and Oak Ridge National Laboratory, the University of Rochester and Brookhaven National Laboratory, and the Universities of Washington and Kansas and the Hanford Atomic Products Operation.

Each fellow receives an annual stipend of $2500, with additional allowances for a spouse and dependent children, and normal tuition, fees, and travel.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

ORTHOPEDIC SURGERY IN INFANCY AND CHILDHOOD. By ALBERT BARNETT FERGUSON, JR., B.A., M.D., Silver Associate Professor Orthopedic Surgery, University of Pittsburgh; Chief of Orthopedic Service, University of Pittsburgh Medical Center; Senior Staff, Children's, Presbyterian and St. Margaret's Hospitals, Pittsburgh; Chairman, Medical Advisory Board, Harmarville Rehabilitation Center; Consultant, Orthopedic Surgery, U. S. Veterans Hospital, Oakland and Green

County Memorial Hospital, Waynesburg. A volume of 508 pages, with 504 illustrations. Published by Williams & Wilkins Co., Baltimore, 1957. Price $15.00.

THE DOCTOR AS A WITNESS. By JOHN EVARTS TRACY, Professor of Law (Emeritus), University of Michigan, Ann Arbor, Mich. A volume of 222 pages. Published by W. B. Saunders Co., Philadelphia & London, 1957. Price $4.25.

CLINICAL USE OF RADIOISOTOPES. A MANUAL OF TECHNIQUE. Edited by THEODORE FIELDS, M.S., F.A.C.R. (Assoc.), Assistant Director, Radioisotope Service, Veterans Administration Hospital, Hines, Ill.; Instructor in Radiology, Northwestern University Medical School; Certified Medical Nuclear Physicist, American Board of Radiology; and LINDON SEED, M.D., Clinical Associate Professor of Surgery, University of Illinois College of Medicine; Director of Isotope Laboratory, Augustana Hospital, Chicago; Consultant in Radioisotopes, Veterans Administration Hospital, Hines, Ill. A volume of 456 pages, with 71 illustrations. Published by The Yearbook Publishers, 200 E. Illinois St., Chicago 11, Ill., 1957. Price $9.50.

THE BIOLOGICAL EFFECTS OF ATOMIC RADIATION. SUMMARY REPORTS FROM A STUDY BY THE NATIONAL ACADEMY OF SCIENCES. A volume of 108 pages. Published by the National Academy of Sciences—National Research Council, Washington, D. C., 1956.

THE MEASUREMENT OF BODY RADIOACTIVITY. British Journal of Radiology Supplement No. 7. Papers Read at a Conference held at Leeds, April 16–17, 1957. Editor: C. B. ALLSOPP. With a foreword by Professor F. W. Spiers, D.Sc. A volume of 130 pages with numerous illustrations and tables. Published by the British Institute of Radiology, London, England, 1957. Price 25*s*.

A RADIOLOGICAL STUDY OF THE BRAIN CIRCULATION BY RAPID SERIAL ANGIOGRAPHY OF THE CAROTID ARTERY. Acta radiologica Supplement 140. By TORGNY GREITZ. From the Roentgen Department, Serafimerlasarettet, Stockholm, Sweden (Director: Professor Erik Lindgren). A monograph of 124 pages, with numerous illustrations and tables. Published by Acta radiologica, Stockholm 2, Sweden, 1956. Price Sw. Kr. 30.

STUDIES ON THE DISTRIBUTION OF TRITIUM-LABELLED DIHYDROSTREPTOMYCIN AND TETRACYCLINE IN THE BODY. Acta radiologica Supplement 142. By TORSTEN ANDRÉ. From Farmakologiska Avdelningen, Kungl. Veterinärhogskolan, Stockholm, Sweden. A monograph of 90 pages, with 41 illustrations. Published by Acta radiologica, Stockholm 2, Sweden, 1956. Price Sw. Kr. 25.

ROENTGEN CHANGES IN THE CRANIUM IN 153 INTRACRANIAL TUMOURS IN CHILDREN AGED 0–15 YEARS. Acta radiologica Supplement 141. By HELGE HERTZ, M.D., and THOMAS ROSENDAL, M.D., Rigshospital Neurosurgical Department, Copenhagen (Chief: Professor E. Busch, M.D.) and Sundby Hospital Roentgen Department, Copenhagen (Chief: Thomas Rosendal, M.D.). A monograph of 54 pages, with 32 illustrations, 7 diagrams, and 6 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1956. Price Sw. Kr. 30.

RECTOSCOPIE SIGMOÏDOSCOPIE. By R. BENSAUDE. Third edition entirely revised by P. HILLEMAND, A. LAMBLING, R. CATTAN, and A. BENSAUDE. A volume of 270 pages, with 127 text illustrations and 39 color plates. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris 6e, 1956. Price 7400 francs.

INTESTIN GRÊLE: COLON—RECTUM. By G. ALBOT, ET AL. Under the direction of GUY ALBOT, Médecin de l'Hôtel-Dieu, Paris, and FÉLIX POILLEUX, Chirurgien de l'Hôpital Corentin-Celton. Actualités hépato-gastro-entérologiques de l'Hôtel-Dieu, 1955. A volume of 362 pages, with 168 illustrations. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris 6e, 1956. Price 3400 francs.

GUIDE TECHNIQUE ET TOPOGRAPHIQUE D'EXPLORATION BRONCHOLOGIQUE (BRONCHOSCOPIE ET BRONCHOGRAPHIE). By JEAN IOANNOU, Médecin-adjoint au Sanatorium de Chevilly, Attaché de bronchoscopie à la Clinique de Pneumo-Phtisiologie de la Faculté de Paris, in collaboration with L. DUCHET-SUCHAUX and A. PINELLI, Médecins-adjoints au Sanatorium de Chevilly. Preface by Dr P. Chadourne, médecin-directeur du Sanatorium de Chevilly. A volume of 114 pages, with 66 illustrations. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris 6e, 1956. Price 1400 francs.

CHIRURGIE DU PANCRÉAS. By LUCIEN LÉGER, Professeur agrégé à la Faculté de Médecine de Paris; Chirurgien des Hôpitaux de Paris, and JACQUES BRÉHANT, Professeur agrégé à la Faculté de Médecine d'Alger. Monographies chirurgicales (Collection Henri Mondor). A volume of 504 pages, with 154 illustrations. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris 6e, 1956. Price 4800 francs.

# Book Reviews

ROENTGEN SIGNS IN CLINICAL DIAGNOSIS. By ISADORE MESCHAN, M.A., M.D., Professor and Director of Radiology, Bowman Gray School of Medicine of Wake Forest College, Winston-Salem, N. C.; Formerly Professor and Head of the Department of Radiology at the University of Arkansas School of Medicine, Little Rock, Ark. With the Assistance of R.M.F. FARRER-MESCHAN, M.B., B.S. (Melbourne, Australia). A volume of 1,058 pages, with 2,216 illustrations including roentgenograms. Published by W. B. Saunders Co., Philadelphia & London, 1956. Price $20.00.

In this work on *Roentgen Signs in Clinical Diagnosis* the author has set out to describe the basic signs which are recognizable on the roentgenogram and to discuss the forces which produce them. The work is intended especially as a teaching guide. In accord with this aim, most of the material is arranged according to roentgen appearances rather than by disease processes. The text is divided into thirty-one chapters ranging from roentgen equipment and protection, through the skeletal system, chest, heart, abdomen, urinary tract, gallbladder, gastrointestinal tract, obstetrics and gynecology. Under these various headings the author reviews the anatomy of the area, the technical aspects of the roentgen studies applicable to the region, and the radiographic pathology. The descriptions of diseases, such as pulmonary tuberculosis, cover general pathology and physiology and the appearances produced on the film.

The text is clear and readable, though the description of many conditions is necessarily brief, because of the attempt to cover the entire field of roentgen diagnosis in one volume. The illustrations are profuse, including roentgenograms and line drawings which are of great aid to the reader. While the author has sought to describe signs rather than disease processes, this is a difficult concept to follow completely.

The book is a valuable one and will be a welcome addition to every roentgenologist's library. It will be of special benefit to radiological residents and students for its description of the basic roentgen signs. It will also be helpful to those further advanced in the practice of radiology, and especially to those who are engaged in undergraduate or postgraduate teaching.

MEDICAL EFFECTS OF THE ATOMIC BOMB IN JAPAN. Edited by ASHLEY O. OUGHTERSON, Clinical Professor of Surgery, Yale University School of Medicine; Attending Surgeon, Grace-New Haven Community Hospital, and SHIELDS WARREN, Pathologist, New England Deaconess Hospital, Professor of Pathology, Harvard Medical School. A volume of 478 pages, with numerous illustrations and tables. Published by McGraw-Hill Book Company, Inc., 1956. Price $8.00.

In this comprehensive text the relatively immediate effects of the atom bomb on the population of Hiroshima and Nagasaki are described in good detail.

An initial summary of the contents of the book is followed by an illuminating account of the incredibly delayed medical investigation of the bombed populace. The type and extent of injury due to blast effect, burns, and ionizing radiation are described in relation to distance from the hypocenter and shielding, and the clinical course of the injured is given in some detail.

The latter half of the book is devoted to detailed hematological and pathological studies on material available from casualties and survivors. The division is somewhat abrupt and it is rather difficult for the reader to appreciate the evolution of the clinical picture of radiation sickness and associated laboratory and terminal pathological findings in particular groups of exposed individuals.

Appendixes supply details as to the organization and personnel of the Joint Commission and collaborating groups and the approach to the investigation, as well as listing reports of Japanese scientists and physicians, furnishing studies of population and casualties, and presenting a statistical survey of the survivors.

Throughout the text there is a dearth of physical information regarding the dose and character of the ionizing radiation and radiant heat produced by the bomb, related to the degree of injury. Nor are there any appreciable data regarding residual radioactivity in the area or in the exposed populace, except for a brief bit of general speculation regarding fallout. Presumably this deficiency is no reflection on the perspective of the contributors to this volume, but is rather attributable to the unfortunate lack of availability of this extremely important information.

The writing is ideally direct and simple, and an abundance of plates and tables amplify the text. The illustrations are generally of high quality, although the photomicrographs would be greatly improved were it feasible to reproduce them in color. The bibliography is extensive, but the index is hardly adequate to cover the abundance of data in the text.

In this atomic age, with the constant threat of nuclear explosions, every physician, and indeed all medical personnel, should study this book so that, should such a catastrophe occur, those who survive will be better able to anticipate and deal more efficiently with the problems that arise.

MEDIZINISCHE RÖNTGENTECHNIK. LEHRBUCH FÜR MEDIZINISCH-TECHNISCHE ASSISTENTINNEN, ÄRZTE UND STUDIERENDE, IN ZWEI TEILEN. MEDIZINIS-

CHER TEIL: SKELETTAUFNAHMEN UND ORGANUNTERSUCHUNGEN. By Prof. Dr. HERBERT SCHOEN, Karlsruhe, with the assistance of Dr. DETLEV SCHOEN, Marburg/Lahn. A volume of 348 pages, with 537 illustrations. Published by Georg Thieme, Stuttgart. Second enlarged edition, 1956. Distributed in the United States and Canada by the Intercontinental Medical Book Corp., New York 16, N. Y. Price DM 29.70—($7.00).

This text on radiographic technic and positioning is the second edition of a handbook which has been found most usable in the x-ray laboratories of Europe. The descriptive matter is brief and precise, and is closely tied in with the illustrations, to which it is conveniently contiguous. The illustrations themselves are chiefly photographs arranged in triads consisting of a surface picture, a reproduction of a skeletal facsimile, and a roentgenogram. In most of the roentgenograms the bone appears white to correspond to the usual appearance on the viewing box.

Only conventional views are considered, no verbiage being wasted on the one-shot-a-year procedures. The author's personal contribution to roentgen technic, the Schoen bridge, is frequently suggested as an accessory to positioning. This radiolucent wedge is well known for its usefulness.

Following the principal portion of the book, which is on the skeleton, appear sections on arthrography, venography, arteriography, fluoroscopy of the lungs, examination of the gastrointestinal tract, and urinary tract studies. The methods of Martius, Guthmann, Caldwell-Moloy, and Thoms are included in the section on pelvimetry, but no mention is made of William Snow. The concluding pages deal with myelography, encephalography, and foreign-body localization.

DIE LUNGENTUBERKULOSE. DIAGNOSE UND THERAPIE. By Prof. Dr. Med. PAUL-GEORG SCHMIDT, Chefarzt der Westerwaldklinik Waldbreitbach, Tuberkulose-Krankenhaus der LVA Rheinprovinz. Third edition, completely revised. A volume of 384 pages, with 234 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1956. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N.Y. Price DM 58—($13.80).

The European popularity of Professor Schmidt's handbook on tuberculosis is attested by the fact that the second edition, which appeared in 1947, was out of print by 1948. The third edition, now appearing, has been enlarged especially as concerns the therapy of tuberculosis. The emphasis on treatment indicates that the work is designed for the general practitioner and the advanced student. More than one third of the text is devoted to medical and surgical treatment, including chemotherapy, antibiotics, sanatorium care, and the various forms of collapse therapy. The principles of lung resection and of decortication are also given. This is not a surgical volume and surgical technics are not described.

The usual program for a text of this nature is followed. The history and the bacteriology of the tubercle bacillus are mentioned. Chapters deal with pathologic anatomy, physical findings, laboratory studies, and the clinical course. Individual sections include those on the primary complex, hematogenous spread, adult type tuberculosis, pleural involvement, and spread beyond the lungs. There is nothing on differential diagnosis. No particular effort is made to emphasize the roentgen features, although adequate illustrations in this connection are included.

The book is substantially bound, adequately indexed, and moderately easy to read. The physicians most likely to benefit from its purchase are those German-reading internists who are interested in the medical management of tuberculosis.

LES ÉCRASEMENTS THORACIQUES. By JEAN GARBAY, MICHEL GARBAY, and CLAUDE VANDERPOOTEN. Preface by Dr. Sauvage. A monograph of 132 pages, with 12 roentgenograms. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris 6°, 1956. Price 1100 fr.

This small monograph is an interesting treatise on crushing injuries of the thorax sustained in automobile accidents or following similar severe trauma. The mechanisms of various traumatic incidents, pathologic anatomy, physiology, and therapy are all discussed. The types of injury in order of frequency are parietal lesions, pleuropulmonary tears, vascular ruptures, cardio-pericardial lesions, bursting of the thoracic canal, and rupture of a bronchus. Post-traumatic pulmonary complications which are considered include the wet lung, atelectasis, acute edema, embolism, and bronchopulmonary infections. Among extrathoracic complications are acute renal insufficiency, rupture of the liver, spleen or kidney, head injuries, and fractures of the spine and extremities.

It is emphasized that corrective surgical therapy must be associated with close attention to pathophysiologic alterations in order to rehabilitate the patients.

DIAGNOSTICS PNEUMOLOGIQUES. By A.-P. JARNIOU, Professor agrégé du Val-de-Grâce, Chef du Service de Pneumo-phtisiologie de l'Hôpital-Percy. With a Preface by Dr. Roger Even, Médecin de l'Hôpital Laënnec. A monograph of 148 pages, with 28 roentgenograms on 14 plates. Published by G. Doin & Cie, 8, Place de l'Odéon, Paris 6°, 1956. Price 1350 fr.

This monograph has to do with the problems posed by the finding of various roentgen shadows, clinical conditions, or related disease groups in the

chest. For example, if one finds an isolated rounded opacity in a roentgenogram of the chest the first thing to determine is whether it is within the lung or is extrapulmonary. Following this, the various etiologic possibilities must be considered, including the means of excluding certain conditions or finding positive evidence of other disease processes.

Many other diagnostic problems are posed, including the detection of mediastinal lymphadenopathy, bullous images, miliary densities, pleural changes, and suppurative conditions. Separate chapters are devoted to a clinical consideration of carcinoma, lymphoma, and sarcoidosis.

In general, the text follows the line of thinking of the experienced chest physician or radiologist who is presented with a diagnostic problem in thoracic disease. A monograph of this type is probably of most value to the medical student, intern, or resident who is interested in learning a practical clinical approach to diagnosis in diseases of the chest.

ÉTUDES SUR LA PRÉCISION EN RADIODIAGNOSTIC. TECHNIQUES D'UN NOUVEAU CRANIOGRAPHE. NOTATION ANGULAIRE DE L'INCIDENCE. By G. L. DULAC, Ancien Chef de Service à la Fondation Curie. With a preface by M. Bouchet, Oto-rhino-laryngologiste honoraire des Hôpitaux de Paris. A monograph of 134 pages, with 47 figures. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris 6e, 1956. Price 1300 fr.

While tribute is due to many pioneers in the field of radiology who have developed equipment and technics for examining the head and neck, more precise methods are often needed for accurate diagnosis. This monograph describes a new craniograph which permits stereoradiography, image enlargement and tomography of the skull, pharynx, and larynx with great precision.

A device which is radiolucent, with lines marked at intervals, is used to study the anatomy in the anteroposterior and lateral positions. Another device has been constructed which suspends a dry skull with protractors for determination of the best angle of incidence for demonstrating anatomic structure.

The work described in this monograph lays the foundation for more exact radiography of the head and neck.

# IN MEMORIAM

## LEONARD GREEN CROSBY, M.D.

1873–1957

Dr. Leonard Crosby, for more than fifty years in the practice of medicine in the Rocky Mountain area, died on Feb. 17, 1957.

Dr. Crosby was born in New Auburn, Minnesota, on Jan. 26, 1873, the son of James W. and Elsie Green Crosby. Following his preparatory education, he attended Milton College in Milton, Wisconsin, for two years, after which he taught school in Minnesota. He began the study of medicine in 1895 in Hamlin University in Minneapolis, later transferring to the University of Illinois, from which he was graduated in 1899. While still a medical student, he married Katherine Waterman of Milton, who died in 1930. In 1931, he married Mrs. Helen Root, who preceded him in death by only a few weeks.

Dr. Crosby began his medical practice in Janesville, Wisconsin, but soon removed to Ouray, Colorado, where he practiced from 1902 until 1914. In the latter year he moved to Denver to become associated first with Dr. George H. Stover and later with Dr. Samuel B. Childs, in the practice of radiology.

He served as roentgenologist to St. Joseph's Hospital for more than thirty-five years, and was also on the staffs of Denver General Hospital, Mercy Hospital, and Colorado General Hospital.

During World War I, Dr. Crosby was a Captain in the Medical Corps of the United States Army and head of the radiological service of Base Hospital No. 29, at Totenham, England.

A member of the Colorado State Medical Society for more than half a century, Dr. Crosby contributed to the scientific programs in the early days of the Coolidge tube. He was a past president of the Denver Medical Society and served as the first president of the Rocky Mountain Radiological Society. He was a Fellow of the American College of Radiology and a member of the Radiological Society of North America and the Colorado Radiological Society.

Endowed with a rugged constitution, Dr. Crosby led an active life. He loved the out-of-doors, and could usually be found working in his yard during his leisure time. His long career was well rounded, including religious and civic as well as professional activities. He was an Episcopalian and a vestryman in his church. He was a Mason, and a member of the Denver Chamber of Commerce. Though many will mourn his death, his loss will be felt especially by his fellow radiologists of the Rocky Mountain region, who held him in high regard for his constructive council and as a gentleman, friend, and physician of integrity.

EDWARD J. MEISTER, M.D.

## EVARTS A. GRAHAM, M.D.

1883–1957

Dr. Evarts A. Graham, at one time awarded the gold medal of the Radiological Society of North America, though not himself a radiologist, died on March 4, in Barnes Hospital, St. Louis.

Dr. Graham was born in 1883, the son of Dr. David W. Graham and Ida Barnet Graham. He was graduated from Princeton University in 1904 and received his M.D. from Rush Medical College, Chicago, in 1907. His early work was done at Rush Medical College and Presbyterian Hospital, Chicago. He served in World War I as a Major in the Army Medical Corps, being attached to the School of Neurological Surgery in Chicago and the Empyema Commission, Camp Lee, Va. Following his discharge from the Army, he became Bixby Professor of Surgery at Washington University, St. Louis, with which he was actively associated until 1951. In that year he retired as head of the department of surgery and as chief surgeon to Barnes Hospital, to whose growth he had so greatly contributed. He continued his association with

the University, however, as Professor Emeritus and remained active in research.

Though Dr. Graham's award from the Radiological Society was for his work in cholecystography, it was as a chest surgeon that he became most widely known. His is the credit for the first successful removal of an entire human lung, in 1933. Lung cancer claimed his special attention and his studies in this field, especially as concerned the relation of cancer to smoking, won him the annual award of the American Cancer Society in 1951. He was recipient also of the Leonard Research Prize of the American Roentgen Ray Society in 1925, of the gold medal of St. Louis Medical Society in 1927, and the gold medal of the Southern Medical Association in 1933. He was chosen to deliver the Lister Oration in England in 1947.

Dr. Graham was one of the founders of the American Board of Surgery and was President, in 1953, of the International Congress of Surgeons. He was a crusader for improved medical care and for the elimination of such abuses as fee-splitting and so-called "ghost surgery."

Surviving Dr. Graham are his widow, Helen Tredway Graham, Professor of Pharmacology in the Washington University School of Medicine, and two sons, Evarts A. Graham, Jr., and Dr. David T. Graham.

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# ROENTGEN DIAGNOSIS

## THE HEAD AND NECK

**The Normal Variations in the Position of the Optic Recess of the Third Ventricle.** James Bull. Acta radiol. **46:** 72–80, July-August 1956. (St. George's Hospital, London, England)

The author has examined 117 normal pneumoencephalograms representing all age groups from birth to seventy years, the object being to assess the position of the third ventricle and thus the optic chiasm. The tuberculum sellae was chosen as the reference point and it was found that the position of the optic recess varied considerably in its relation to that structure. This finding was generally in keeping with Schaeffer's anatomic findings (Anat. Rec. **28:** 243, 1924).

The author believes that suprasellar masses can become much larger than is generally appreciated before clinical signs develop. This is especially true if there is a great forward tilting of the sella, combined with a long intracranial portion of the optic nerves.

Eight illustrations. J. P. CHAMPION, M.D.
Grand Rapids, Mich.

**The Anatomy of the Subarachnoid Cisterns.** B. Liliequist. Acta radiol. **46:** 61–71, July-August 1956. (Roentgen Department, Serafimerlasarettet, Stockholm, Sweden)

Investigation of the subarachnoid space has been important in the past. With more exact anatomical knowledge it should be of even greater value in the early recognition of intracranial expanding lesions. The author has made a careful correlation with the location of the cisterns and their radiographic appearances. This was done by fixing the brain with intra-arterially injected formaldehyde and then injecting into the cisterns a gelatin solution of barium sulfate. Various films were obtained, after which the cranial vault was opened and the brain removed. Additional routine films and tomograms of the brain and subarachnoid cisterns were then made. The appearances of the cisterns in these films and in dissected specimens are compared with a large number of normal encephalograms.

A detailed report of the boundaries and appearances of the cisterns is given, with emphasis on the normal variations.

Twenty-one roentgenograms; 1 photograph.
J. A. GUNN, M.D.
Grand Rapids, Mich.

**Changes in the Size of the Subarachnoid Spaces after the Insufflation of Air.** Jan Jirout. Acta radiol. **46:** 81–86, July-August 1956. (Neurologic Clinic, Charles University, Prague, Czechoslovakia)

The size of the cerebrospinal fluid pathways is not constant but may change during or after pneumoencephalography. Such changes are the result of edema of the surrounding brain tissue due to the irritating effect of air. They may be influenced by varying the position of the patient's head or by injecting hypertonic saline solutions intravenously. The greatest changes are seen in patients with closed head injuries. In these cases the signs of brain edema are most evident and the beneficial effect of glucose solutions is most dramatically demonstrated.

The author cites 127 cases in which 80 ml. of 40 per cent glucose was injected intravenously immediately after pneumography. Films of these patients made at five, ten and fifteen minute intervals following the injection showed immediate widening of the subarachnoid spaces in 107 patients (84.25 per cent). In 46 the subarachnoid spaces were studied in the same way without the administration of intravenous glucose. In 44 cases (95 per cent) there was no change.

In some patients it is possible, by comparing the width of the pontine and intercrural cisterns, to discover changes in the relationship between the pons and the clivus. In anteflexion of the head the pons moves forward toward the clivus while in the supine position the reverse occurs. These movements cannot be seen in cases of posterior fossa tumor. The sign may therefore be of value in differentiating between a neoplastic and non-neoplastic lesion in the posterior fossa.

Variations in the position of the upper cervical medulla in the spinal part of the cerebellomedullary cistern may also be useful diagnostically. Herniation of the cerebellar tonsils causes a permanent forward displacement of the cord. Disturbances in the motility of the upper cervical medulla in the spinal canal may make possible the diagnosis of a tumor in the region of the foramen occipitale magnum, where this is often difficult on standard films and ordinary myelograms.

Sixteen figures, illustrative of variation in size of the ventricles and subarachnoid spaces.

H. C. JONES, M.D.
Grand Rapids, Mich.

**Diagnostic Value of Encephalographic Examination of the Subarachnoid Space.** Giovanni Ruggiero. Acta radiol. **46:** 99–108, July-August 1956. (Neurosurgical Centre of the Ste-Anne Hospital, Paris, France)

Objection has been raised to the use of encephalography in brain tumor suspects for several reasons, including the frequent poor visualization of the ventricular system, in which case the patient is said to have been subjected to an unnecessary risk. The author believes, however, that non-filling or poor visualization of the ventricules does not necessarily make the procedure worthless.

Of 680 encephalograms, 85 were unsatisfactory for ventricular visualization. In 53 of these the unsatisfactory filling was due to the presence of a tumor. In cases of non-filling, posterior fossa tumors prevailed, while cases of incomplete filling (only one lateral ventricle seen) were most commonly associated with tumors of the hemispheres. Filling of only the infratentorial portion of the ventricular system occurred chiefly with central and mid-line tumors.

The diagnosis of a cerebellar tumor in the absence of ventricular filling is based on flattening of the pontine cistern, signs of herniation of the cerebellar tonsils, and evidence of hydrocephalus. Alterations of the cisterns of the posterior fossa and brain stem, when present, supply additional diagnostic aid.

In cases with filling of only one lateral ventricle, the following three signs are of significance: the relationship between the septum pellucidum and the third ventricle, the appearance of the subarachnoid space, and the contours of the filled ventricle. Non-filling or

poor filling of the subarachnoid spaces on the convexity of the brain is of some value, but deformation, especially of the sylvian fissure, is more useful.

Brain stem tumors, mid-line supratentorial tumors, and tumors growing into the central gray matter are difficult to diagnose when only the infratentorial part of the ventricular system is filled. Study of the cisterns in the brain stem region can at times be helpful in these cases. The appearance of the cisterna venae magnae Galeni is a helpful sign for the differential diagnosis between brain stem tumor and non-neoplastic stenosis of the aqueduct.

Large, diffuse bilateral tumors are the most difficult diagnostic problems, with unsatisfactory ventricular filling. Ventriculography or arteriography may be necessary for the diagnosis.

Fifteen illustrations; 6 tables. J. A. GUNN, M.D.
Grand Rapids, Mich.

**Encephalography of Sellar and Parasellar Tumors, with Particular Reference to the Anteroposterior Projection and Olfactory Sulci.** Joseph Hanelin and Louis Bakay. Acta radiol. **46:** 474–479, July-August 1956. (Departments of Radiology and Neurosurgery, Massachusetts General Hospital, Boston, Mass.)

The authors discuss the value of encephalography for sellar and parasellar tumors, with particular reference to the anteroposterior projection and the olfactory sulci. This procedure provides a means for accurate determination of the size, contour, and location of neoplasms in this area.

It is not too generally appreciated that the suprasellar cisterns can be satisfactorily projected in the anteroposterior view. This is true whether the cisterns are normal or pathologically distorted. When the central ray is angulated caudally between 20 and 35°, these cisterns will be thrown clear of the obscuring paranasal sinuses and sphenoid wings. If the transverse measurement of the suprasellar mass is 2 cm. or more, the resulting deformity of the suprasellar cisterns can be detected in the anteroposterior view.

Because of their location the olfactory sulci will lie inferior to the basal cisterns in films with caudal angulation, and their most anterior aspects will be situated inferiorly. The characteristic inward slope of these fissures as they incline inferiorly is emphasized. It is the posterior portions of the sulci which may be deformed by sellar or parasellar lesions. Tumors situated more anteriorly may also cause deformity of these cisterns, but of their more rostral extensions.

As is true of other paired sulci of the brain the olfactory sulci may not always be symmetrical even normally. Asymmetry must be reasonably marked to be considered significant. Failure of the olfactory sulci to fill or unilateral filling is not necessarily a pathologic abnormality.

Twelve illustrations. THEODORE E. KEATS, M.D.
University of Missouri

**Positive Contrast Ventriculography—A Critical Evaluation.** Norman H. Horwitz. J. Neurosurg. **13:** 388–399, July 1956. (2719 Brandywine St., N. W., Washington 8, D. C.)

The author reviews the subject of positive contrast ventriculography and presents 5 representative cases, in which Pantopaque was used. He considers this method to be a real asset in the diagnosis of posterior fossa lesions. It should never be considered, however, as a replacement of or an alternative to gas ventriculography. This latter procedure should always be the initial choice. In cases where it shows minimal shifts or incomplete filling of the fourth ventricle and where decision for surgical intervention is difficult, positive contrast studies are often helpful.

The technic for manipulating the contrast material is described in detail. The interpretation of positive contrast roentgenograms needs little amplification. The distortion from space-occupying obstructive lesions is in no wise different from that observed in negative contrast studies except that it is more easily visualized since no superimposed shadows are present to confuse the picture.

It is felt that, when one is faced with imminent surgery on a patient who is deteriorating, the possibility of obtaining valuable information would outweigh the long-term risk of Pantopaque arachnoiditis.

Five representative cases are reported.

Eight roentgenograms; 4 drawings.

THEODORE E. KEATS, M.D.
University of Missouri

**Cerebral Angiography in a Neurosurgical Service.** Stevens Dimant, C. P. Moxon, and N. A. Lewtas. Brit. M. J. **2:** 10–16, July 7, 1956. (S. D., Neurosurgical Department, Manchester Royal Infirmary, Manchester, England)

The authors reviewed 1,556 carotid angiograms obtained on 1,007 patients over a four-year period. General anesthesia was preferred for children and restless or uncooperative patients. Out-patients and patients with elevated intracranial pressure received a local analgesic (about 90 per cent of the series). The percutaneous technic was used. Diodone was the contrast material. Sensitivity tests were not considered necessary as no serious reactions had been encountered. Three per cent of the examinations were considered failures and were repeated.

One hundred ninety-six aneurysms were diagnosed angiographically. Two were missed and found at autopsy. Thirty-six angiomas were identified, although 2 were found only after re-examination because recent hemorrhage had caused compression of the fistulous vessels. The site of intracerebral clots was indicated in 13 instances, angiography proving more accurate than electroencephalography for this purpose.

Subarachnoid hemorrhage was always investigated by means of bilateral carotid angiography. Vertebral angiography was performed only in the event of severe repeated hemorrhages, when carotid angiograms were negative, or when there was clinical evidence of a posterior fossa angioma. In 80 such examinations, 8 angiomas were discovered, 6 of which were demonstrable by carotid angiography. Angiography in subarachnoid hemorrhage is advised at the earliest possible moment, provided the patient is not in deep coma.

Four out of five subdural hematomas were identified. A bilateral frontal hematoma was missed, supporting the opinion that angiography is not a substitute for bilateral burr-hole exploration.

Twenty-seven cerebral and 17 carotid artery thromboses were identified angiographically; 73 patients with clinical degenerative vascular disease showed no thrombosis but many had minor arteriosclerotic changes. Three such changes (variations in curvature and course of arteries) were misinterpreted as due to tumor.

Of 355 patients with space-occupying lesions, 88 had some identifying angiographic abnormality; 74 per cent of the lesions were correctly located in terms of lobes and depth; 39 per cent were identified as to site and type of tumor (metastasis, glioblastoma, astrocytoma, meningioma, and others).

Of 16 tumors with normal angiographic findings, only 3 were intracerebral. Thirteen were extracerebral and related to the base of the skull. In 10 of these, plain roentgenograms revealed evidence of the tumor.

Myodil ventriculography was considered safer and superior for posterior fossa tumors and was used for all such suspects.

Progress angiograms were obtained to demonstrate postoperative obliteration of aneurysms, the fate of fistulae, the extent of tumor removal and its recurrence, and for continued observation of suspected brain tumor patients.

The most common complication of angiography was local hematoma, requiring overnight admission in 5 per cent of cases. Three patients required prophylactic tracheal intubation. Following angiography 1 patient died of myocardial infarction and 1 of cerebral infarction; 6 patients had hemiparesis, transient in 3.

Three tables; one graph.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

**New Method of Total Simultaneous Cerebral Angiography by Rapid Intravenous Injection.** P. Viallet, L. Sendra, L. Chevrot, P. Combe, P. Descuns, and P. Aubry. Acta radiol. **46:** 273–278, July-August 1956. (In French) (Laboratoire d'Électro-Radiologie, Hôpitaux Civils d'Alger, Algiers, Algeria)

**Utilization of Total Simultaneous Cerebral Angiography by the Intravenous Route in the Child.** Ch. Pheline, P. Viallet, L. Sendra, P. Combe, L. Chevrot, and P. Aubry. Acta radiol. **46:** 279–282, July-August 1956. (In French) (Clinique Médicale Infantile, Hôpitaux Civils d'Alger, Algiers, Algeria)

The development of efficient roentgenologic apparatus and good contrast agents have permitted the exploration of the total circulation with rapid intravenous injection of the medium, followed by the administration of physiologic serum. This method is applicable in all age groups and is without risk. Only in this way can an accurate appraisal of circulation times both on the venous and arterial sides be made. The first of the two papers listed above is concerned mainly with the cerebral circulation.

The advantages of this technic are that the carotid and the vertebral artery circulation can be demonstrated at the same time and that good visualization of the venous return is obtained. Indeed, phlebography by this route is probably less capricious than with the usual method. Arterial spasm is avoided.

In the second of the two papers, the authors elaborate upon the results obtained in children by using their technic of simultaneous cerebral angiography. The procedure is especially suitable for these young patients. Eight to ten examinations can be done in a morning. Many of the patients need not be hospitalized but can leave the department one to two hours after the examination. General anesthesia is not used.

The findings in 35 children with encephalopathy, who ranged in age from a few months to fourteen years, are described. The method was of value in the diagnosis of cerebral atrophy, both the localized and diffuse varieties, and the diagnosis of hydrocephalus was easily made. An especially useful application was the demonstration of a generalized or localized slowing of the circulation. The authors believe that they have come upon a new syndrome characterized by generalized slowing of the arterial blood flow, mental retardation, unconsciousness, etc. Only by this physiologic method could such an entity be discovered.

The findings in 3 cases of craniofacial dysostosis are also described.

In the Discussion following these two papers, Ruggiero (of Paris) stated that he could see no reason why the intravenous technic should be preferred to percutaneous arterial puncture. Much larger amounts of contrast substance are required for the intravenous injection and reactions are without question due to the quantity and concentration of the opaque material within the brain. Smaller and smaller amounts, as little as 2 or 3 c.c. of a 50 per cent solution, have been found adequate for the intra-arterial method.

Rather than simplifying interpretation of the roentgenograms, total visualization of the arterial system, actually makes it more difficult, according to this discussant.

Viallet claimed that the intravenous method would put cerebral angiography back into the hands of the radiologist, where it belongs, to which Ruggiero replied that it is already there, at least in the major centers which have made the great contributions to its development. Indeed, the intravenous method, because of its apparent simplicity, would actually tend to remove the procedure from the hands of the radiologist, with harmful effects.

Five roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**The Diagnostic Value of Functional Serial Angiography in Intracranial Lesions.** W. Schiefer. Acta radiol. **46:** 299–309, July-August 1956. (In German) (Max-Planck-Institut für Hirnforschung, Abteilung für Tumorforschung und experimentelle Pathologie des Gehirns, Köln, Germany)

The author reviewed the findings encountered in 2,500 angiographic studies in which both the direct serial method of Tönnis-Bergerhoff and indirect cinematography (Odelca) were employed. His purpose was to establish and evaluate changes observed in the cerebral circulation in the area of the lesion and the rest of the brain, and to correlate these with various pathological conditions.

It was sometimes difficult, or impossible, to establish a differential diagnosis on the basis of the arterial phase alone, as for example in glioblastoma, meningioma, or metastatic lesions. Emphasis is placed, therefore, upon studies relative to the speed of circulation of the opaque medium throughout the brain and the tumor area. By this means the presence of shunts in angiomas and glioblastoma multiforme can be determined. Other glioblastomas and the presence of astrocytomas or oligodendrogliomas can also be diagnosed by evaluation of circulation time, and especially the capillary and venous phases, as demonstrated by the Odelca camera.

The author concludes that the importance of cerebral angiography is not limited to observation and demonstration of displacement of arteries, veins, and vascular changes in the tumor, but that, by analysis of the relationship existing between the cerebral circulation and

the tumor circulation, special functions of individual intracerebral processes can be ascertained which are helpful in arriving at a differential diagnosis.

Thirteen angiograms; 4 tables and diagrams.

JULIAN O. SALIK, M.D.
Baltimore, Md.

**Serial Angiographic Study of the Circulatory Dynamics of the Brain.** E. Woringer, A. Langs, J. P. Braun, and J. Baumgartner. Acta radiol. **46**: 357–363, July-August 1956. (In French) (L'Hôpital Pasteur de Colmar, Colmar, France)

The rate of the cerebral circulation was determined in 152 serial angiographic studies in normal and abnormal brains in man and in dogs. The contrast medium was 35 per cent Diodone, 8.0 c.c. being injected in two seconds. One film a second was taken for a minimum of 10 films.

In normal man, the cerebral circulation time ranged from seven to ten seconds; the arterial phase two to three seconds, the capillary phase one to two seconds, and the venous phase three to six seconds. These figures were not significantly modified by changing the conditions of angiography (local or general anesthesia) or varying the amount and concentration of the contrast material. Even in the normal brain the circulation time was not necessarily the same on both sides.

In the presence of a cerebral tumor the circulation time in general exceeds the normal by one to three seconds. This increase was especially striking in the gliomas and in the venous phase. Apart from those cases in which the tumors were directly visualized by the contrast material and those that produced vascular displacement, at least one of the two following findings was demonstrated: (1) very early opacification, even in the arterial phase, of a vein draining the tumor itself; (2) in the venous phase, heavy opacification in that region of the brain near the tumor.

In circulatory disturbances the cerebral circulation was often prolonged to fifteen seconds, and sometimes even longer. The rate was accelerated in 1 of 2 cases after pericarotid sympathectomy and the removal of the superior cervical ganglion. In controlled hypotension the circulation is slowed but not proportionately to the fall of tension. Slowing is also observed in cerebral edema.

Two charts. CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Angiographic Findings in Cerebral Vascular Disease and Their Relationship to Clinical Syndromes.** R. Frowein. Acta radiol. **46**: 381–389, July-August 1956. (In German) (Nervenklinik der Stadt und Universität Frankfurt a. M., Frankfurt a. Main, Germany)

The author discusses pathological changes due to disturbances in circulation caused by complete or partial obstruction of the carotid artery near its bifurcation or siphon. He feels that the clinical pictures should be grouped according to characteristic symptoms and he concentrates on findings encountered in the region of the medial cerebral artery; of 16 patients with carotid obstruction, all but 1 had changes in that area. In 4 patients there was a complete softening of the sylvian segment, 6 had a large central softening, 2 a partial central, and 3 a peripheral softening. In 1 case there were additional symptoms of changes in the anterior hemisphere. Usually, the latter is well supplied by the anterior communicating artery and no damage occurs.

The author presents 6 cases and concludes that diagnosis could be improved by the use of rapid serial angiographic studies. In this way even small changes in circulation can be detected and their influence evaluated in conjunction with the clinical findings.

Twenty-four angiograms.

JULIAN O. SALIK, M.D.
Baltimore, Maryland

**Carotid Artery Occlusion.** J. E. Webster, E. S. Gurdjian, and F. A. Martin. Neurology **6**: 491–502, July 1956. (801 David Whitney Building, Detroit 26, Mich.)

The authors report their observations in 70 patients with carotid artery occlusion in whom the diagnosis was made angiographically. Internal carotid artery thrombosis was demonstrated in 58 instances, thrombosis at the level of the siphon in 5 cases, at the middle cerebral artery in 4 cases, at the anterior cerebral artery in 2 cases, and at the posterior cerebral artery in 1 case.

The studies were generally performed by the closed method of injection, with Thorotrast as the contrast medium in all patients over fifty years of age or in those sensitive to Diodrast. Later, Hypaque was employed, in all age groups. Earlier, angiography was performed in patients with evidence of cerebral hemorrhage; the indications were subsequently broadened to include all patients with major "stroke" syndromes, as well as those with recurrent "strokes," with or without bloody spinal fluid.

The roentgen pattern in complete carotid artery occlusion is obvious, as the contrast substance is arrested in its upward flow into the brain. Identification of partial occlusion, although more difficult, was achieved in some of the present cases. These occlusions are usually located at the beginning of the internal carotid as it leaves the carotid bulb.

Since it is important that the carotid bulb be demonstrated, as well as the cerebral circulation, the contrast medium is injected directly into the common carotid artery. Many of the studies in this series were performed under local anesthesia. Complications resulting from the procedure were minor.

Twenty-one illustrations, including 17 roentgenograms; 2 tables.

**Angiographic Differentiation Between Acute and Chronic Subdural and Extradural Haematomas.** Olof Norman. Acta radiol. **46**: 371–378, July-August 1956. (University Hospital of Lund, Lund, Sweden)

The author discusses the radiographic differentiation between acute chronic subdural and extradural hematomas.

Roentgen changes occurring during the first few days after trauma differ distinctly from those in the chronic subdural hematoma. In the acute phase, in the anteroposterior view the brain is seen to be pressed away from the lamina interna, but without any changes in its contour even when the hematoma is large. This is in contrast to the typical appearance in the chronic case, where the vessels in a limited area on the surface of the brain are lifted from the lamina interna and outline the hematoma in a regular concave curve.

An analysis of 64 cases of subdural hematoma showed that during the first two weeks there is an even spread, without change in the outline of the brain; later, signs of expansion and, from the fourth week, typical appearances of chronic hematoma become evident.

The extradural hematomas (11 cases) consistently showed signs of pronounced expansion from the beginning. These characteristics often permit the differentiation of the two types.

Twelve angiograms; 2 diagrams.

THEODORE E. KEATS, M.D.
University of Missouri

**Repeated Angiographic Examinations During Roentgen Therapy of Brain Tumors.** A. Breit and J. Peiffer. Acta radiol. **46**: 469–473, July-August 1956. (In German) (Max Planck-Institut, Munich, Germany)

The authors divide their material into primary tumors of the brain (predominantly glioblastomas) and metastases and summarize briefly their angiographic observations during irradiation. No statistics are given and only 4 cases are reported, 2 in each classification.

The findings in the glioblastomas were not consistent: about half showed no change in appearance of the tumor at the conclusion of irradiation some four to six weeks after the first angiogram; in others the tumor had actually grown, but in an occasional case the tumor vessels had disappeared. These findings, however, proved to be of limited prognostic value. Metastatic lesions showed a similar lack of uniformity.

The authors state that drawing conclusions from their observations is difficult. Their findings indicate that only seldom are the clinical and angiographic findings parallel. At the same time, it is shown that irradiation can influence an intracranial tumor. One of the cases reported clearly indicates that the late post-irradiation effects on the vascular system of the brain can be visualized on the angiogram.

Eight roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Vertebral Angiography in the Diagnosis of Hydrocephalus and Differentiation Between Stenosis of the Aqueduct and Cerebellar Tumour.** F. Olov Löfgren. Acta radiol. **46**: 186–194, July-August 1956 (Roentgendiagnostic Department, University Clinics, Lund, Sweden)

An investigation was undertaken to determine when hydrocephalus may be detected angiographically and whether vertebral angiography can distinguish stenosis of the aqueduct from tumor of the cerebellum. The material consisted of 12 cases of stenosis of the aqueduct and 36 cases of cerebellar tumor. Angiography and pneumography were done in all. The tumor cases were histologically proved. Stenosis of the aqueduct was verified operatively and clinically.

Hydrocephalus was recognized in 18 of the patients with tumors and in 9 of those with aqueduct stenosis. The differentiation of the two conditions was possible in all but 3 cases. It was found that hydrocephalus to be demonstrable must be pronounced, whether in association with tumor or stenosis.

Cerebellar tumors were found to cause vascular displacement, a feature which served to distinguish them from stenosis. The posterior cerebral arteries were displaced upward in 14 cases, while there was arcuate upward displacement of the superior cerebellar arteries in 31 cases. The cranial loop of the inferior posterior cerebellar artery was displaced downward in 21 cases and the caudal loop in 17. Three tumors were not large enough to produce any expansive effect and therefore could not be recognized angiographically.

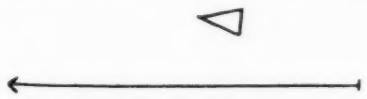
In stenosis of the aqueduct, the course of the superior cerebellar artery is normal. In 2 of the cases in the author's series the caudal loop of the posterior inferior cerebellar artery was displaced downward. With this exception, the only vascular change was straightening of the posterior cerebral artery in the presence of pronounced hydrocephalus.

Seven roentgenograms; 3 diagrams.

CAPT. BYRON G. BROGDON
U.S.A.F. Hospital, Parks AF Base, Calif.

**Phlebography in Tumours of the Hemispheres and Central Grey Matter.** E. Laine, J. M. Delandtsheer, P. Galibert, and G. Delandtsheer-Arnott. Acta radiol. **46**: 203–214, July-August 1956. (Centre Hospitalier Régional de Lille, Service de Neurochirurgie, Lille, France)

The authors point out the value of detailed study of the venous phase of cerebral angiography as a further means of localization of cerebral space-occupying lesions. On the basis of their experience with 69 normal phlebographic studies (done at a target-film distance of 80 cm.) they have constructed a topogram which is illustrated in actual size and might be copied on transparent plastic or cleared film for use in localization problems. The topogram consists of a straight



Normal topogram × ½

line, extending between the limbus sphenoidalis and the confluence of the great cerebral vein with the straight sinus, and an associated isosceles triangle with a 7 mm. posterior base and 13 mm. height which lies above this line. The location and size of the triangle was determined by the normal variations of the position of the point of junction between the thalamostriate (striate) and internal cerebral veins. The latter angle marks the position of the foramen of Monro.

This point is deviated in a consistent and characteristic way by tumors in various anatomical locations in the hemispheres, according to the experience of the authors. Superimposing the topogram over a phlebogram allows one to check the position of the venous angle described in relation to the normal position as outlined by the triangle. Application of the rules of characteristic deviation described in the text facilitates the localization of certain tumors. The alteration of other cerebral veins produced by tumors in various cerebral locations is expertly described.

The authors point out that the use of the topogram is limited to those over fifteen years of age, since the relationship of the veins and skull in children differs considerably from that in adults. One must be careful not to mistake filling of the thalamotrigonal vein for that of the thalamostriate vein.

Twelve illustrations.

G. M. STEVENS, M.D.
Palo Alto, Calif.

**Changes in the Superficial Veins in Cases of Intracranial Expanding Processes.** V. Gvozdanović. Acta radiol. **46**: 195–202, July-August 1956. (University Hospital "Rebro," Zagreb, Yugoslavia)

The author has previously shown that, on account of

numerous anastomoses, the entire network of superficial cerebral veins function as a unit. The present study of 500 normal cranial phlebograms indicates that the cranial convexities drain in the direction of the superior longitudinal sinus, transverse sinus, and cavernous sinus in a relatively regular fashion and that the ascending veins are fairly equally distributed. The generally accepted thesis of complete irregularity of the superficial veins is rejected and it is suggested that failure of superficial veins in a large area to fill, irregularities in their course, and change in the direction of drainage must be of pathologic significance.

The author presents illustrative cases and makes a plea for study of the venous phase in rapid-film cerebral angiograms.

Sixteen roentgenograms.

CAPT. BYRON G. BROGDON
U.S.A.F. Hospital, Parks AF Base, Calif.

**Vertebral Angiography in Supratentorial Expansive Processes.** F. Columella and I. Papo. Acta radiol. **46:** 178–185, July-August 1956. (Neurosurgical Department, Surgical Clinic of the University of Milan, Milan, Italy)

The authors describe their experience with 105 cases of supratentorial expansive processes in which vertebral angiography was done after carotid angiography. They believe vertebral angiography should follow carotid arteriography in three types of cases: (1) when carotid angiography reveals a supratentorial expansive process, but the posterior cerebral artery is not demonstrated and there is doubt as to whether the tumor is temporal, parietal, or occipital; (2) when a supratentorial lesion is shown, but the posterior cerebral artery is not demonstrated and the clinical findings suggest a larger tumor, extending toward the posterior parts of hemispheres or deeply toward mid-line structures; (3) when carotid angiography reveals hydrocephalus. Vertebral angiography will often demonstrate the tumor location in these cases.

Changes in the vertebral angiogram produced by tumors in the above three groups are described. In conclusion it is pointed out that vertebral angiography should be used only to complement the carotid study and that, as with the latter, normal findings do not exclude the presence of an expanding process. The authors feel, however, that the assistance they have received from this study has been of great practical value and has eliminated the need for a considerable number of ventriculograms.

Eight roentgenograms; 1 drawing.

CAPT. BYRON G. BROGDON
U.S.A.F. Hospital, Parks AF Base, Calif.

**Contributions to Cerebral Angiography.** H. Neuenschwander and H. R. Renfer. Schweiz. med. Wchnschr. **86:** 826–828, July 21, 1956. (In German) (Röntgeninstitut der Universität und des Inselspitals, Bern, Switzerland)

A new needle for cerebral angiography is described. It consists of a trocar needle with a blunt cannula. The injection can be done without rubber tubing, and the needle can remain for several minutes in the vessel without blockage or damage to the intima.

The authors also report their experience with Urografin in 60 per cent solution. This they had used in 55 patients with 149 injections, in amounts of 4 to 11 c.c., with only one complication (hemiplegia and aphasia due to cerebral thrombosis).

Six roentgenograms; 1 photograph

JULIUS HEYDEMANN, M.D.
Chicago, Ill.

**Angiography and Pneumography in the Diagnosis of Slightly Space-Occupying Supratentorial Tumours.** I. Wickbom. Acta radiol. **46:** 158–170, July-August 1956. (Roentgen Department III, Sahlgrenska Sjukhuset, Gothenburg, Sweden)

The author has attempted to assess the diagnostic value of angiography and pneumography in infiltrating brain tumors presenting only slight clinical symptoms. His material, limited to proved cases, was broken down into four groups. Group 1, in which only angiography was done, consisted of 71 cases, for the most part highly vascular tumors. Group 2 comprised 16 cases, primarily hypophyseal adenomas with suprasellar extension. Group 3 included 54 cases in which the side of the lesion was not indicated clinically. In this group pneumography was performed first, followed by angiography to obtain additional information as to the extent and nature of the lesion. Group 4 was made up of 30 cases which for the most part produced little change in the angiogram but were demonstrable by pneumography. Several of these are presented in the paper.

The author concludes that there are still cases in which the correct diagnosis of a brain tumor cannot be made by only one of the two methods at our disposal (pneumography and angiography). Most tumors, however, can be diagnosed by one method if the other fails or by the results of the two considered jointly.

Thirty-seven roentgenograms.

CAPT. NEIL E. CROW
U.S.A.F. Hospital, Parks AF Base, Calif.

**Scintiscanning as a Method for Localization of Cerebral Tumors.** Robert L. Bell, Asa B. Friedmann, and B. Wesley Olson. J. Neurosurg. **13:** 344–348, July 1956. (A. B. F., 257 New York Ave., Brooklyn 16, N. Y.)

The authors describe a technic for automatic scanning of the head after intravenous injection of radioactivated iodinated serum albumin which has been successful in the localization of various types of brain tumors. This localization is made possible by directional detection and a moderately sensitive recording device. The scanner is a modification of a thyroid scanning device.

The material consisted for the most part of gliomas of the cerebrum. Patients were prepared by blocking the thyroid gland by the oral administration of Lugol's solution, following which the radioactive iodinated serum albumin was injected. Scanning was performed twenty-four to forty-eight hours later. Abnormal uptakes in the cerebrum on the side of the tumor were found to occupy specific areas of the neoplasm. Sharp borders of the tumor were seldom recorded, apparently because of regional necrosis of the brain and/or irregular invasion of adjacent tissue by the neoplastic process.

It is hoped that in the near future, with the use of a sensitive electronic circuit and a more specific tumor metabolite, the method will become effective for a greater variety of neoplasms.

Five illustrations.

THEODORE E. KEATS, M.D.
University of Missouri

**Radiologic Diagnosis of Intraventricular Meningeomas.** Bengt Falk. Acta radiol. **46:** 171–177, July-August 1956. (Roentgen Department, Serafimerlasarettet, Stockholm, Sweden)

This paper deals only with meningiomas of the *lateral* ventricles. These are comparatively rare tumors, but some 60 cases have been recorded in the literature. The author discusses 9 cases of his own and compares his experience in their roentgen diagnosis with that of Wall, who published 8 cases (J. Neurol., Neurosurg. & Psychiat. **17:** 91, 1954) and of Huang and Araki, who presented 5 cases (J. Neurosurg. **11:** 337, 1954. Abst. in Radiology **64:** 756, 1955).

The changes on conventional films are those of increased intracranial pressure or calcification and are not specific. Clinical findings are not diagnostic. In most cases described in the literature, air studies (usually ventriculography) demonstrated an intraventricular tumor. It is often difficult, however, to decide whether the growth arises in the ventricle or extends into it from a parenchymal lesion. Displacement of the ventricle is not a reliable sign.

From observations on 4 cases which were studied with arteriograms, as well as the cases of Wall and the Japanese authors, it is felt that an enlarged anterior choroid artery, with lengthening of the artery and a tangle of vessels, common in meningiomas, is helpful in establishing the diagnosis. Cases are cited to show that this is not without exception, however. When the anterior choroid vessel does not fill, vertebral angiography may show typical meningioma changes in the choroid plexus. A definite preoperative diagnosis should be possible in most cases.

Fifteen roentgenograms. CAPT. NEIL E. CROW
U.S.A.F. Hospital, Parks AF Base, Calif.

**Two Years Experiences with a Cisterno-Encephalographic Technic.** M. Lenzi and G. C. Canossi. Acta radiol. **46:** 87–91, July-August 1956. (In German) (Röntgeninstitut der Universität Modena, Modena, Italy)

The procedure for pneumoencephalography devised by the senior author and called by him "cisterno-encephalography" consists essentially in examining the patient prone upon a specially devised tilt-table with a saddle and supports for the axillae and shoulders (see Fortschr. a. d. Geb. d. Röntgenstrahlen. **80:** 479, 1954. Abst. in Radiology **64:** 284, 1955). After the lumbar puncture, air injection is carried out according to the well known fractionation technic, the gas being directed into the appropriate spaces by modifying the flexion of the head. The advantages of the method derive from the specially designed table, which allows examination of the conscious or unconscious patient in all degrees of tilting, including the Trendelenburg position.

Seven illustrations, including 3 encephalograms.
CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Encephalomalacia Simulating the Clinical and Radiological Aspects of Brain Tumor. A Report of Six Cases.** Giuseppe Scarcella. J. Neurosurg. **13:** 366–380, July 1956. (Baylor University College of Medicine, Houston, Texas)

The differential diagnosis between cerebral vascular disease and a space-occupying lesion is a challenge even to the experienced radiologist. Symptoms suggesting an acute vascular disorder may prove to be due to a tumor. On the other hand, a vascular lesion may produce a clinical picture of cerebral neoplasm which appears to be supported by electroencephalography, roentgenograms of the skull, air studies, and angiography.

The author reports 6 cases with focal neurological signs and increased intracranial pressure in which operation failed to reveal evidence of a neoplasm, but in which the diagnosis of infarction and encephalomalacia was established.

Skull roentgenograms in 2 cases revealed a significant pineal shift away from the infarcted area. Air studies were done in all cases, showing ventricular displacement toward the side opposite the infarction with a single exception, in which there was no air filling the ventricular system. Because of the massive and diffuse nature of the infarcted area, usually in the distribution of the middle cerebral artery, accurate localization by the ventriculographic appearance was extremely difficult. In only 2 cases was the lesion apparently pinpointed satisfactorily; in the remainder less accurate interpretation was made as to the areas involved. Only one angiogram was done in this series. This revealed an apparent posterior or middle temporal lobe lesion, with no evidence of vascular occlusion.

The authors suggest that the infarction, with surrounding edema, acts as a mass lesion exercising a compressive action on a neighboring structure. Removal of the infarcted area was performed in the 3 cases, and appears to offer a more satisfactory prognosis than does partial removal or simple biopsy.

Eight roentgenograms; 1 photograph.
THEODORE E. KEATS, M.D.
University of Missouri

**The Significance of Digital Impressions in Children's Skulls.** George du Boulay. Acta radiol. **46:** 112–122, July-August 1956. (Department of Radiology, St. Bartholomew's Hospital, London, England)

The author compared the roentgen findings in the skulls of 199 normal children with those in 159 patients with increased intracranial pressure. He sought to determine whether or not increased intracranial pressure produced any changes in the digital markings of the skull and, if so, how long it must exist before the changes manifest themselves.

The technic employed was derived from Macaulay (Brit. J. Radiol. **24:** 647, 1951). The frontal, parietal, and occipital areas were compared in turn. Marks were assigned to each area according to the following method:

(*a*) No impressions visible.....0
(*b*) Few shallow impressions.....1
(*c*) Deep and extensive impressions .....3
(*d*) Impressions intermediate between (b) and (c).....2

The criteria upon which the diagnosis of increased intracranial pressure was judged were: history of headache and vomiting; presence of papilledema; measurement of cerebrospinal fluid pressure at ventriculography or lumbar puncture; presence of suture diastasis; changes in the sella turcica in the absence of local disease.

The following conclusions are reached: About ten weeks of increased intracranial pressure is required to produce significant change in the digital impressions of the cranial vault. Before a lapse of this interval,

however, other radiologic signs of increased intracranial pressure will usually be evident. The normal appearances are variable. Extensive and heavy impressions may sometimes be found in the absence of increased pressure. On the other hand, some cases with high pressure show no change in the convolutional markings. Deep and numerous digital markings, if found alone, may be of no significance but, accompanied by other signs of increased intracranial pressure, may indicate a long-standing condition.

Ten diagrams and two illustrative roentgenograms are included.

H. C. JONES, M.D.
Grand Rapids, Mich.

**Developmental Changes of the Skull as Seen on Roentgenograms.** K. H. Schiffer. Acta radiol. **46:** 123–129, July-August, 1956. (In German) (Universitäts-Nervenklinik, Mainz, Germany)

The author cites the paper by Dyke, Davidoff, and Masson (Surg., Gynec. & Obst. **57:** 588, 1933. Abst. in Radiology **22:** 516, 1934) concerning cerebral hemiatrophy in conjunction with homolateral hypertrophy of the skull and sinuses, and discusses 7 of his own cases exhibiting different neurological findings. He believes that the presence of hyperplasia or hypoplasia of the frontal sinuses as seen on roentgen examination can be of considerable value in contributing to the differential neurological diagnosis of changes occurring in the formative stages of the brain in the prenatal and postnatal period.

Six roentgenograms.

JULIAN O. SALIK, M.D.
Baltimore, Md.

**Tentorial Herniations.** N. Azambuja, E. Lindgren, and S. E. Sjögren. Acta radiol. **46:** 215–223 (Anatomy), 224–231 (Pneumography), 232–241 (Angiography), July-August, 1956. (Roentgen Department, Serafimerlasarettet, Stockholm, Sweden)

I. *Anatomy:* One hundred cases of cerebral tumor were studied roentgenologically with reference to tentorial herniation. Anterior, posterior, and complete (anterior and posterior herniations so large that they join) forms, unilateral and bilateral, are recognized. Anterior tentorial herniations are most frequent, though "complete" herniations are relatively common also. The gross anatomical relationships involved in the herniations were studied and from this the radiologic detection of the displacement of the subarachnoid cisterns and vascular structures was clarified. Tentorial herniations were more common than occipital in the supratentorial lesions.

Fourteen illustrations, 4 charts and tables.

II: *Pneumography:* With the use of pneumoencephalography tentorial herniations may be detected. Anterior herniations deform the crural and/or intercrural cisterns, while posterior herniations displace the wing of the cisterna ambiens and at times may deform the anterior cerebellar surface. From the experience of the authors, pneumography seems best adapted to demonstration of downward tentorial herniations. Upward herniations are more often successfully shown by arteriography.

Twelve roentgenograms; 3 photographs.

III: *Angiography:* While the detection of tentorial herniations is not the primary purpose of cerebral angiography, the procedure is likely to yield valuable information of such an occurrence. Particularly is this true of vertebral angiography and upward herniations. Under the latter circumstances upward deviation of the superior cerebellar and medial posterior choroidal arteries is seen. Compression, from below, of the vein of Galen against the splenium is also apparent.

Anterior downward herniations depress the posterior cerebral artery in its anterior part while the posterior communicating artery is seen to follow a more downward course than normal, in the lateral view. The anteroposterior view discloses medial displacement of the posterior cerebral and sometimes of the posterior communicating artery.

In posterior herniations the posterior part of the posterior cerebral artery is displaced medially, as seen in the half-axial view. The phlebogram may show a similar displacement of the posterior part of the basal vein.

As seen in the lateral view, complete herniations produce a depression of the posterior cerebral artery along the entire length of the tentorial notch, with typical acute angles in the occipital and temporal branches as they pass the edge of the tentorium. Anteroposterior views show considerable medial displacement of the vessels.

Anterior herniations of sufficient size to fill the intercrural cistern depress the basilar artery and produce a typical accordion-like deformity. The cisternal portion of the choroidal artery may also be deflected by anterior herniations due to its intimate relationship with the uncus.

Sixteen angiograms; 1 photograph.

G. M. STEVENS, M.D.
Palo Alto, Calif.

**Transtentorial Herniation of the Brain as Revealed by the Displacement of Arteries.** Antony Jefferson and Philip Sheldon. Acta radiol. **46:** 480–498, July-August 1956. (Departments of Neurological Surgery and Radiology, The Radcliffe Infirmary, Oxford, England)

The authors discuss transtentorial herniation of the brain as shown by displacement of the anterior choroidal, posterior communicating, and posterior cerebral arteries. Herniation of different portions of the hippocampal gyrus, including the uncus, may be recognized.

To determine how often the anterior choroidal and posterior cerebral arteries could be identified radiologically, in anteroposterior and lateral views, 100 unselected angiograms from cases of intracerebral tumor and 50 angiograms regarded as normal were examined.

The anterior choroidal artery was recognized in the lateral view in about the same proportion of cases in the two groups. In the anteroposterior view it is often more difficult to make out the course of this artery, not only because the contrast is poorer, but also because it may be obscured in the early part of its course by the posterior cerebral artery and in its later course by several of the small "perforating" arteries. Among the normals satisfactory identification was obtained in 66 per cent of cases; among the tumor group in only 23 per cent.

Satisfactory filling of the posterior cerebral artery was seen in the lateral view in 24 per cent of the normal group. A further 14 per cent showed evidence of posterior cerebral filling, but it was insufficient to allow the course of the vessel to be accurately determined. In the tumor group there was a pronounced increase in the demonstration of filling of this artery on the lateral view.

It is suggested that the differences in filling of these vessels between the normal and the tumor group is the result of a change in the blood flow in the circle of Willis during transtentorial herniation of the brain.

This method of radiologic recognition of transtentorial herniation of the brain remains at the moment such a relative innovation that its usefulness cannot yet be fully assessed. This article should be read in its entirety by those interested in this problem.

Twenty-seven illustrations, including 16 roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

**The Anterior Choroidal Artery.** S. E. Sjögren. Acta radiol. **46:** 143–157, July-August 1956. (Roentgen Department, Serafimerlasarettet, Stockholm, Sweden)

The topography and roentgenologic anatomy of the anterior choroidal artery are considered on the basis of 30 specimens and 100 normal angiographic studies. At the same time the pathologic changes were observed in some 400 carotid angiograms. In both series a comparison was made between the pneumographic and angiographic findings in the same patient.

The anterior choroidal artery was identified in both the anteroposterior and lateral views in 93 per cent of the normal cases. In 3 cases the vessel could not be identified in either view. The rapid-film method of angiography proved to be far superior to slower methods of visualization. Typically the artery arises from the posterior aspect of the carotid siphon just above the posterior communicating artery. The distance above the bifurcation of the internal carotid artery averages 0.5 cm.

For purposes of description, the author recognized two parts of the artery. The first, or "cisternal," lies in close connection with the medial and posterior surfaces of the uncus, describing a curve between that structure and the cerebral peduncle and continuing laterally across the anterior part of the ambient cistern to the choroidal plexus in the temporal horn. The rest of the artery, lying within the choroidal plexus is referred to as the "plexal" part. Detailed anatomical relationships of both the plexal part and cisternal part are discussed.

The primary object of the pathological studies was to determine whether any conclusions could be drawn regarding the location of the temporal horn from the appearance of the choroidal artery in cases with different types of temporal horn displacement. In general, displacement of the horn posteriorly corresponds to displacement of the point where the plexus begins. The cisternal part of the artery is stretched. Upward displacement of the anterior temporal horn causes elevation of the choroidal plexus, while the cisternal portion of the artery is stretched in a curve to reach the temporal horn. If a posterior tumor is situated basally, it elevates the posterior part of the plexus. If the lesion is higher up, behind the long axis of the temporal horn, it compresses the latter and makes the anterior choroidal artery accordion-shaped. Central expanding lesions stretch the anterior choroidal artery in a curve around the lesion. Other changes in the artery in relation to variously situated lesions are described and two conclusions are drawn. Without changes in the temporal horn, the plexal part of the choroidal artery is not affected. The cisternal part is changed by expanding processes flattening the medial surface of the uncus, and by anterior down-herniations.

Twenty-two roentgenograms; 1 drawing.

CAPT. NEIL E. CROW
U.S.A.F. Hospital, Parks AF Base, Calif.

**Segmental Radiography of the Internal Auditory Canal in Neurinomas of the Eighth Nerve.** H. Fischgold, J. Metzger, and M. Juster. Acta radiol. **46:** 130–142, July-August 1956. (In French) (Clinique Neuro-Chirurgicale de la Pitié, Paris, France)

The authors report studies of 16 patients with suspected neurinoma of the internal auditory canal. Their technic of examination includes, in addition to the standard procedures, the projections of Stenvers and Chaussé with double magnification, tomography, and varying penetrations. They divide the neurinomas into a lateral group of intrapetrous origin, and a medial or internal group of extrapetrous origin, involving only the groove and modifying the porus later. The x-ray findings were confirmed in 8 of the cases which came to operation.

Radiographically, the internal auditory canal cannot be considered a single unit, but must be divided into segments: the medial sulcus, the orifice marking the entrance of the canal, the canal itself, and its lateral end. The elaborate technics employed by the authors are required for complete and individual visualization of these four segments.

There are three types of evolution of acoustic neurinoma, which will modify the roentgen findings: In the first, the neurinoma dilates the internal canal but its contours remain intact; in the second, the neurinoma remains within the internal auditory canal, but its walls are eroded or hypertrophied; in the third, the neurinoma dilates the canal, its contours are partially or wholly destroyed, and the tumor develops within the petrous bone.

Radiologic diagnosis is possible in the early stages of neurinomas of the lateral type. For the medial type, encephalography is probably the more efficient early diagnostic method.

Fifteen roentgenograms: 3 drawings.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Radiologic Investigation of Pharyngeal and Laryngeal Palsy.** G. M. Ardran and F. H. Kemp. Acta radiol. **46:** 446–455, July-August 1956. (Department of Radiology, United Oxford Hospitals, Oxford, England)

Patients with difficulties in swallowing of neurologic origin are seldom referred for radiologic examination on the grounds that the roentgen findings are of little value. The authors urge that this policy be changed and report their experience in cases of pharyngeal and laryngeal palsy. Some of their observations follow.

Abnormalities of palatoglossal closure with spill into the pharynx on chewing or on holding the bolus in the mouth while supine was seen in many patients after tonsillectomy in whom the anterior pillars of the fauces had been damaged.

Abnormalities of the movements of the tongue included deflection of the bolus in hypoglossal nerve palsy and in patients with an operative defect on the side of the face. Deflection of the bolus to one or both sides of the tongue is usually seen in patients with a cleft palate.

Limitations of movement of the tongue due to fibrosis

or infiltrative processes such as myositis or scleroderma were observed. Weakness and/or slowness of movements occur in many conditions, including myasthenia gravis. Disordered or dysrhythmic movements were noted in various states resulting in spasticity.

Defective clearance of the bolus from the mouth was associated with a variety of disorders. Failure to initiate a swallowing reflex has been observed in some young babies.

Abnormalities in nasopharyngeal closure occurred in some patients with bulbar palsy and after surgical excision of the uvula. Other abnormalities were noted in patients with bulbar poliomyelitis and cleft palate.

Abnormalities of pharyngeal clearance accompanied poliomyelitis, polyneuritis, muscular dystrophy, general debility, or infiltrative processes such as scleroderma. Inhibition of pharyngeal movements was sometimes due to obstruction in the esophagus. Disordered movements may be seen with partial paralysis. Failure of the epiglottis to turn down normally occurred in all cases of pharyngeal palsy.

Abnormalities of the lateral food channels were also noted. One food channel may be paralyzed, obstructed, or otherwise abnormal without the patient complaining of any symptoms. Food may pass readily through a paralyzed food channel but is not squeezed or stripped from it. In predominantly unilateral palsy it appears that the patient tends to turn the head to the opposite side, thus closing the relatively normal channel.

The cricopharyngeus muscle often failed to open completely in patients with bulbar palsy, with the result that the bolus tended to build up in the pharynx.

Hold-up in the esophagus at any level may result in partial inhibition of pharyngeal movements. The residue left in the pharynx may hinder re-expansion of the airway and may sometimes penetrate the larynx and enter the lower airway.

Cases of suspected vocal cord paralysis are best examined by tomography supplemented by cineradiography. Entry of food into the lower airway may result from paralysis or weakness of the vestibular sphincter, with failure of the larynx to close during passage of the bolus through the pharynx. Presence of a large residue in the pharynx when swallowing is occluded may allow food to enter the lower airway when the larynx is open to re-establish the airway, the laryngeal sphincter mechanism in such cases working normally.

This paper is illustrated by cinefilms of four patients showing various causes of defective pharyngeal clearance.

THEODORE E. KEATS, M.D.
University of Missouri

**Cervical Oil Myelography with Full Hyperextension of the Neck. A Modified Technique.** F. Dalith. Radiol. clin. **25**: 212–220, July 1956. (In English) (Government Hospital, Tel-Hashomer, Israel)

In the performance of myelography, a complete cervicocranial arrest of the oil column may be effected by maintaining full hyperextension of the neck, regardless of the degree of table-tilt. Cervical filling is obtained with a tilt-angle of 65 to 70°, but fluoroscopic visualization of the cervical segment is not possible at this angle because of superimposition of the occiput. When none of the contrast medium remains in the lumbar or dorsal region the table is returned to a horizontal position, the degree of hyperextension of the neck is slowly reduced, and the contrast column as a whole can now be moved at will in either direction by changing the inclination of the table. Reestablishment of hyperextension will accentuate any filling defect from a posterior nuclear herniation. Spot-films are made in the anteroposterior and oblique projections, followed by lateral conventional radiography with the head neutral and hyperextended. The posterior subarachnoid space is visualized with the patient on his back.

The radiographic appearance of the "block" at the cervicocranial region is described, and its anatomic basis is explained.

Fourteen roentgenograms; 1 diagram.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Aqueous Humor Outflow: An Experimental Study Using Radiopaque Materials. 1. Paracentesis Technique, Response Evoked, and Demonstration of Pathway of Outflow.** Bruce E. Cohan. Arch. Ophth. **55**: 792–799, June 1956. (University of Michigan Medical School, Ann Arbor, Mich.)

A technic of introducing radiopaque materials into the anterior chamber of the rabbit's eye is described. The three media used were sodium acetrizoate 30 per cent (Urokon Sodium), 18 injections; diatrizoate sodium 50 per cent (Hypaque), 8 injections; and sodium iodipamide 20 per cent (Cholografin), 3 injections. Three cubic centimeters of the medium was introduced into one eye of the experimental animal after withdrawal of an equal amount of aqueous humor. The opposite eye served as a control, the aqueous humor being similarly withdrawn and then reinjected.

The response of the eyes to the control procedure of entering the chamber and to the test procedure of injecting the three water-soluble radiopaque substances into the anterior chamber, as determined with the tonometer, the slit-lamp, and histologic examination, is discussed. The path of aqueous outflow in the rabbit from the anterior chamber through the ciliioscleral sinus to the aqueous veins is illustrated. The quantitative aspects of the study will be presented in another article.

Four roentgenograms; 1 diagram.

## THE CHEST

**Some Anomalies of the Respiratory System.** S. Whately Davidson. J. Fac. Radiologists **8**: 1–18, July 1956. (Royal Victoria Infirmary, Newcastle upon Tyne, England)

This is a brief discussion of the radiographic features of tracheal bronchi and lobes, agenesis of the lung, and sequestrated lobes. Several cases of each anomaly are presented.

Tracheal bronchi, known also as "tracheal accessory lungs," may show minor variations in the arrangement of the radicles, but all consist primarily of an abnormal branching of the trachea into 3 instead of 2 main divisions. The condition has no specific radiographic appearance, and is recognizable only by bronchoscopy or bronchography. It is discovered only by chance unless the accessory lobe is diseased. In all reported cases respiratory symptoms have been present.

Agenesis of the lung is more easily discovered. Roentgenograms show tracheal shift and mediastinal rotation to the affected side. Chest symmetry and

equal respiratory movements on both sides of the thorax help to rule out complete collapse of a lung.

Pulmonary sequestration may be represented by single or multiple opacities in the lung base, usually on the left, posteromedially. They may be lobulated or pyramidal, with a tendency to taper toward the diaphragm. Sometimes the lobe contains cystic areas. Tomography, examination with barium meal, and angiocardiography will help in differential diagnosis. Final diagnosis usually depends on surgery and histology.

Included in the article is a well written, concise review of the embryology of the respiratory system.

Thirty-four roentgenograms; 2 drawings; 1 table.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**The Localization of Pulmonary Collapse-Consolidation.** C. J. Hodson. J. Fac. Radiologists **8:** 41–49, July 1956. (University College Hospital, London, England)

The author presents a method for localizing segmental pulmonary disease from postero-anterior chest films by the use of slight overexposure and application of the principle of the "outline sign" or "silhouette sign" (Kane: Radiology **59:** 229, 1952. Lubert and Krause: Radiology **56:** 165, 1951)

Disease of the lung which lies in contact with a portion of the heart, diaphragm, or lung fissures, will affect the clarity of outline of these structures in the area of contact. In addition, an area of increased density of lung or pleura causes the rib outlines behind it to become less sharply defined. If this is kept in mind, and exposure is so adjusted that the rib and diaphragm outlines can be seen through the heart shadow, it is possible to deduce the location of a segmental consolidation with considerable accuracy on postero-anterior films alone. *For example:* consolidation of the medial segment of the right middle lobe causes loss of sharp definition of the right heart border, while the outlines of horizontal fissure and diaphragm remain clear. *For another:* consolidation of the posterior basal segment of either lung causes loss of sharp definition of the ribs and vertebral interspaces while the outlines of the heart and diaphragm remain clear.

On lateral chest films, the vertebral bodies normally decrease in density, evenly and gradually from above downward to the diaphragm. When there is diminished aeration of any overlying lung tissue, there will be an abrupt change in the normal gradient of density indicative of disease.

A diagrammatic and explanatory scheme for identifying the various lung segments is presented. This system, it is pointed out, has especial value in disease of multiple lung segments, where the lateral chest film shows the segments superimposed. It is valuable also for cases where "portable" examinations must be made on severely ill patients.

Fifteen roentgenograms; 2 drawings.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Radiological Diagnosis of Obstructive Emphysema.** Leonard J. Bristol. Arch. Indust. Health **13:** 144–146, February 1956. (Trudeau-Saranac Institute, Trudeau, N. Y.)

This brief article on the roentgen aspects of obstructive emphysema is a contribution to a symposium on Pulmonary Emphysema and the Occupational Dust Diseases at the 14th Annual Congress on Industrial Health, A.M.A., 1954. The author believes that "it may be stated with a high degree of certainty that, while radiologic procedures can be employed in deciding whether or not a patient has diffuse obstructive emphysema, the exact degree of pulmonary impairment must be determined by physiologic studies. Bullous emphysema can be readily diagnosed from chest roentgenograms and by fluoroscopy. If pulmonary dysfunction results from this condition, it can be determined by a study of films taken in expiration and inspiration. Very often pulmonic interstitial emphysema can be detected by roentgenologic examination. This diagnosis is definite when mediastinal involvement is present."

Six roentgenograms; 1 graph; 1 diagram.

**Focal Carnifying Necrotizing Pneumonia and Its Differentiation from Carcinoma of the Bronchus.** E. Zdansky. Radiol. clin. **25:** 193–206, July 1956. (In German) (Institut für Röntgendiagnostik und Strahlentherapie der Universität Basel, Basel, Switzerland)

The type of pneumonia described here is a focal, circumscribed, and mostly solitary process. It usually comes to surgery with the preoperative diagnosis of carcinoma. This chronic inflammatory process shows no tendency toward spontaneous resolution. The symptoms are minimal and uncharacteristic, and the condition is often a chance roentgen finding.

Careful x-ray examination, especially stratigraphy, will allow a differentiation from bronchial carcinoma in typical cases. The extensions into the surrounding parenchyma are coarser than the fine infiltrating network of a tumor. Stratigraphy discloses irregular, "worm-eaten" central radiolucencies which are the most characteristic sign of this entity. These correspond to multiple abscesses but may be absent early in the process, or later may be filled with secretion. In contrast, the cavity in lung tumor is almost always solitary. Hilar lymph node enlargement is absent.

It is impossible to differentiate these lesions from tuberculosis on the basis of the radiologic picture alone.

The author reports 5 cases.

Eighteen roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Chronic Bronchitis, Emphysema, and Bronchial Spasm in Bituminous Coal Workers. An Epidemiologic Study.** John Pemberton. Arch. Indust. Health **13:** 529–544, June 1956. (Department of Social and Industrial Medicine, University of Sheffield, England)

Studies to determine the prevalence of chronic bronchitis, emphysema, and bronchial spasm were carried out on three unselected groups of men, forty-five to sixty-four years of age, in the United States: 242 bituminous coal workers, 238 industrial workers in a rural area, and 131 employees of a large engineering plant in a medium-sized town (Lynn, Mass.). These conditions were found to be much more prevalent in the coal workers than in the other two groups, and evidence indicated that this increased incidence was occupational in origin.

There was a lack of correlation between the radiologic assessment of pneumoconiosis and the incidence of chronic bronchitis, emphysema, and bronchial spasm.

The reactions of the host to the inhalation of dust

rather than simple accumulation of dust in the lungs appear to determine the development of symptoms and the degree of respiratory disability.

On the basis of this survey and others cited, it must be concluded that the chest roentgenogram is of little value in the diagnosis of the chronic respiratory disease to which coal workers are especially liable. Indeed, the roentgenogram may be misleading if it is used to estimate disability. If it is depended upon in compensation cases, it will result in needless expense, on the one hand, by leading to the compensation of some men who may not be disabled but whose chest roentgenograms show clear evidence of dust and, on the other, to the unjust denial of compensation to men who may suffer from a distressing degree of respiratory disability but whose chest films reveal little or no dust. It would appear that tests of respiratory function, such as the timed vital capacity or the maximum breathing capacity, will reflect the state of pulmonary health of industrial workers more accurately than a chest roentgenogram. In the case of coal workers it would be medically more sound to link industrial compensation to impaired pulmonary function and clinical evidence of disability than to rely on chest roentgenograms.

Two roentgenograms; 12 tables.

**A Study of the Effects on the Lung of Industrial Exposure to Zirconium Dusts.** C. E. Reed. Arch. Indust. Health **13:** 578–580, June 1956. (Corvallis Clinic, Corvallis, Ore.)

The possibility that dusts encountered in the production of zirconium metal might produce pulmonary granulomas was investigated by animal exposure and by clinical and radiographic evaluation of selected employees. No abnormalities attributable to zirconium were found.

One figure.

**Coin Lesions.** J. C. Gerrits. J. belge de radiol. **39:** 696–705, 1956. (In English) (Wilhermina Gasthuis, Amsterdam, Netherlands)

Between 1947 and 1955, coin lesions were found by the authors in 210 patients: 99 (47 per cent) had primary carcinoma, 9 (4 per cent) metastatic carcinoma, and 3 adenoma. Seventeen of the lesions (8 per cent) were tuberculomas, 16 neurofibromas, 16 cysts, and 8 chondromas. The series included also several less common categories, as 6 cases of diaphragmatic hernia, 6 cardiophrenic-angle masses, and 1 case each of mediastinal sarcoma, aortic aneurysm, and fibrosis.

The older the patient and the larger the "coin," the greater the chance of a malignant lesion. Body-section roentgenography helps to identify calcified spots, although their significance as proof of a benign origin should be accepted with caution. A cavity within the coin is of limited assistance in diagnosis, as it may be found in infections (tuberculosis, fungous disease, abscess), as well as in cancer. Bronchography was performed in 96 cases and revealed in 34 a peripheral obstruction to the flow of Lipiodol, which at least identified the segment for the surgeon. Bronchoscopy is of limited value, except in juxtahilar lesions. Sputum examinations were positive for tumor cells in 74 per cent of the 99 cases of "round cancer," and this procedure is believed to be of considerable diagnostic significance. Exploratory thoractomy is indicated whenever the exact nature of the "coin" cannot be otherwise determined within a reasonable length of time.

In 94 of the 210 cases the coin lesion had been discovered by routine chest roentgenography, and in 37 (of the 94) cancer was found, 45 per cent of them still in the operable stage. The author concludes that roentgenography in apparently healthy individuals over forty is still a comparatively efficient method for the detection of operable pulmonary cancer.

Four tables.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

**Pulmonary Metastases.** Ian N. Lee. Dis. of Chest **30:** 85–95, July 1956. (Middlesex Hospital, London, England)

The author sought to assess the value of the x-ray examination as a means of diagnosing pulmonary metastases by correlating the roentgen findings with the pathologic material in 100 unselected cases proved at autopsy. The films were for the most part obtained within a few days of death; in only a single instance was the interval as long as three weeks.

Metastases to the lungs occur by way of the portal vein and liver and by the systemic circulation. Analysis of various malignant neoplasms indicates that metastasis takes place more frequently from sites from which dissemination would be expected to be by way of the systemic circulation. Thus, in this series the primary lesions in over 30 per cent were carcinomas of the larynx, thymus, breast, testis, kidney, thyroid, suprarenals, bones, and fibrosarcomas. Metastasis was less common from cancers of the stomach, colon, rectum, pancreas, and liver, which would spread by way of the portal vein and liver. Lymphatic dissemination was not taken into account.

The metastatic lesions were classified on the basis of size and number, as follows:

| Type | Total | Radiologically positive | Radiologically negative |
|---|---|---|---|
| A. Miliary nodules up to 3 mm. | 8 | 4 | 4 |
| B. Few nodules (up to 5) less than 3 cm. | 35 | 7 | 28 |
| C. Numerous nodules less than 3 cm. | 30 | 23 | 7 |
| D. Isolated large metastases over 3 cm. | 14 | 14 | 0 |
| E. Replacing one lobe or more | 13 | 13 | 0 |
| Total | 100 | 61 | 39 |

Summarizing, the author states that pulmonary metastases were not radiologically visible in 39 per cent of the cases in this series, "an unsatisfactory state of affairs in the assessment of any carcinoma patient."

Six roentgenograms; 7 tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

**The Significance of Pulmonary Coin Lesions.** Paul W. Johnston and Joseph A. Weinberg. West. J. Surg. **64:** 318–320, June 1956. (VA Hospital, Long Beach, Calif.)

The authors have reviewed the so-called coin lesions of the lung and add 44 of their own cases. Of 784 cases tabulated from the literature, 39.2 per cent

represented malignant neoplasms and 39 per cent granulomas. The clinical management of these pulmonary coin lesions is becoming well standardized. Despite many ancillary tests, exploratory thoracotomy and diagnostic biopsy are important for a definitive diagnosis. The authors believe that the same philosophy should be adopted for pulmonary coin lesions as has been universally accepted for discrete nodules of the breast. Laminated calcification may be diagnostic of either a granuloma or a hamartoma. Resection of granulomas may serve to prevent subsequent dissemination of the infection.

Coin lesions may be simulated by (1) dermal nevi; (2) nipple shadow; (3) pleural plaque; (4) encapsulated pleural fluid.

Two tables.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

**Three Cases of Circumscribed Pulmonary Opacities Simulating Tumor.** J. D. Bristow and E. C. Gaulden. Dis. of Chest **30:** 96–102, July 1956. (VA Hospital, Portland, Ore.)

The authors report 3 cases in which admission x-ray examinations were interpreted as revealing pulmonary neoplasms, only to have the findings change or disappear within a comparatively short time, during therapy.

The first patient had a solitary lesion in the right mid-lung field with atelectasis of the right middle lobe and an interlobar effusion between the upper and lower lobes posterior to the hilus. Cardiovascular disease was also recognized. A second x-ray examination about three weeks after the first showed changes in size and shape of the lesion. The authors concluded that the x-ray findings were not due to tumor, but more likely to an interlobar effusion caused by congestive heart failure.

In the second case a large solitary lesion in the left base decreased in size and subsequently disappeared.

The third lesion, a rounded density in the right mid-lung field, also regressed and disappeared.

Ten roentgenograms; 1 table.

HENRY K. TAYLOR, M.D.
New York, N. Y.

**Circumscribed Pulmonary Lesions in Periarteritis Nodosa and Wegener's Granulomatosis.** James V. Rogers, Jr., and Albert E. Roberto. Am. J. Roentgenol. **76:** 88–93, July 1956. (Emory University School of Medicine, Emory University, Ga.)

This is a report of 3 cases of Wegener's granulomatosis and periarteritis nodosa. Wegener's granulomatosis apparently is a variant of periarteritis nodosa characterized by necrotizing granulomata of the respiratory tract, generalized arteritis, and glomerulitis. The disease is progressive, and usually terminates fatally. The roentgen appearance of the pulmonary lesions is somewhat characteristic, consisting of one or more sharply circumscribed areas of infiltration, which undergo irregular central cavitation, usually thick-walled. One of the authors' cases had an area of calcification inside the central cavity. Two of the 3 patients, aged twenty-nine and thirty-two years, died. The third, a fifty-eight-year-old man, recovered.

The authors feel that the disease should be recognizable by the clinical history which is of the periarteritis type, and the x-ray findings.

Thirteen roentgenograms.

PAUL MASSIK, M.D.
Quincy, Mass.

**Chronic Localized Pulmonary Brucellosis.** Lyle A. Weed, Pierce T. Sloss, and O. Theron Clagett. J. A. M. A. **161:** 1044–1047, July 14, 1956. (Mayo Foundation, Rochester, Minn.)

Three cases of chronic localized pulmonary brucellosis are reported in which the lung lesions took the form of circumscribed, fairly large, caseous nodules, demonstrated roentgenographically. (One of these was previously reported by Weed et al.: Am. J. Clin. Path. **22:** 10, 1952. Abst. in Radiology **59:** 782, 1952). The diagnosis was established in each case by culture of *Brucella suis* from the surgical specimen. Thorough bacteriological study, including guinea-pig inoculation, failed to yield acid-fast organisms, *Actinomyces*, fungi, or common pyogenic bacteria as possible causes of the granulomas. The skin and agglutination tests proved of little diagnostic help in the pinpointing of the diagnosis.

The suggestion is made that, as more caseous granulomas of the lungs are subjected to thorough bacteriological investigation, particularly the specimens heretofore called tuberculomas on histologic evidence alone, diagnoses of localized brucellar granulomas of the lungs will increase.

Three roentgenograms; 1 photomicrograph 1; photograph.

SAUL SCHEFF, M.D.
Boston, Mass.

**Chronic Benign Residuals of Coccidioidomycosis.** Nestor M. Hensler and Edward A. Cleve. Arch. Int. Med. **98:** 61–70, July 1956. (N. M. H., 3275th U.S.A.F. Hospital, Parks Air Force Base, Calif.)

The term "chronic benign residual" is here used to describe any pulmonary lesion persisting three or more months after acute pulmonary coccidioidomycosis or otherwise demonstrated to be coccidioidal in origin without evidence of dissemination. The types of lesions observed were pulmonary cavitation; nodular densities, single or multiple, with or without calcification; pleural effusion; fibrosis; and infiltrative lesions. More than one type of sequela can occur in any single case. Thirty-seven patients were studied and in only 11 of these were there past histories of illnesses compatible with acute coccidioidomycosis. It is therefore apparent that three-quarters of the cases will present problems in the identification of pulmonary lesions.

The most frequent problem encountered in handling these lesions arises from the difficulty in distinguishing them from tuberculosis or tumor. When tuberculosis or tumor cannot be excluded, excision of the lesion is necessary to determine the pathology.

Owing to the benign nature of coccidioidal residuals, no active therapy is usually required. Surgery is necessary in cases with severe or persistent hemoptysis and large organized pleural effusions, and it may be advisable in cases of large, blocked, or expanding cavity.

Twelve roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

**Echinococcosis in North American Indians and Eskimos.** Herbert Meltzer, Leslie Kovacs, Thomas Orford, and Matthew Matas. Canad. M. A. J. **75:** 121–128, July 15, 1956. (Charles Camsell Indian Hospital, Edmonton, Alberta)

The literature is reviewed and the symptomatology and morbid anatomy of hydatid disease are described.

The authors then analyze data collected from 108 cases of hydatid cysts found in North American Indians and Eskimos living in the Yukon, Northwest Territories, and Alberta. Echinococcus disease is endemic in these peoples because of their close association with dogs and their generally low levels of sanitation. Of the cases reported, 109 took the form of lung cysts and 71 liver cysts. Chest films showed the lesions predominantly in the posterior portions of the lungs, equally divided on the two sides.

An uncomplicated hydatid cyst of the lung cannot be differentiated from other mass lesions by radiographic means. Once partial rupture has occurred, however, a collection of air in various parts of the cyst or its wall will produce an almost pathognomonic picture characterized by a "double arch" or air-crescent formation. Such cysts show a strong predisposition to rupture spontaneously into the bronchus, with subsequent spontaneous cure in most instances. Pulmonary lesions tend to be found in individuals under ten years of age while the liver cysts predominate in older people. Lesions which rupture into the liver with bleeding will degenerate and calcify, giving a rounded, irregular or smooth calcification thought to be quite characteristic of this disease.

Helpful confirmatory diagnostic laboratory data include skin tests with injection of sterile hydatid fluid (Casoni's test) and high eosinophile counts. The authors believe that the biological and x-ray investigatory technics together will give a correct diagnosis in 90 per cent of cases. Treatment is surgical. For cysts in the lungs, operative procedures include simple cystectomy, lobectomy, or pneumonectomy, depending upon the clinical and individual features. Liver hydatid cysts may be drained and excised.

Six roentgenograms; 1 photograph; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

**Giant Air Cyst(s) as a Sequela of Pulmonary Tuberculosis.** John L. Shek, Jerome A. Cope, and Gordon D. Myers. J. Thoracic Surg. **32:** 96–102, July 1956. (J. L. S., Battey State Hospital, Rome, Ga.)

Six cases of giant air cyst of the lung recognized radiologically in patients with previous proved pulmonary tuberculosis are presented. All the air cysts could be traced to areas of tuberculous infiltration in the series of films taken during the period that the patient was in the hospital. These cysts represented the end-result of continuous resolution and regression of the tuberculous process. They met all of the criteria, roentgenologically, for the diagnosis of giant bulla of the lung, or pneumatocele. No histopathologic evidence of tuberculosis could be found in any instance.

It is generally believed that air cysts develop as the result of contraction of the surrounding tissue, breakdown of the interalveolar septa, and the coalescence and distention of bullae. This mode of formation appears to be applicable here.

Twelve roentgenograms; 1 photograph.

THEODORE E. KEATS, M.D.
University of Missouri

**Recurrent Pulmonary Hemorrhage with Hemosiderosis: So-Called Idiopathic Pulmonary Hemosiderosis.** André J. Bruwer, Roger L. J. Kennedy, and Jesse E. Edwards. Am. J. Roentgenol. **76:** 98–107, July 1956. (Mayo Clinic, Rochester, Minn.)

The authors review briefly 43 cases previously described in the literature and present 3 new cases of so-called idiopathic pulmonary hemosiderosis. This is an entity distinct from pulmonary hemosiderosis due to cardiac disease. The clinical manifestations are hemoptysis, anemia, and pulmonary hemorrhages, which are moderately characteristic roentgenologically. Most of the cases occur in children less than five years of age, and the average duration of life is two years. Thirteen patients have lived four years or more. Acute and chronic types occur. The acute type is characterized by dyspnea, cough, weakness, cyanosis, fever, and pallor. The usual diagnosis is bronchitis or pneumonia. Clubbing, hepatosplenomegaly, and anemia develop later. The anemia responds well to transfusions and iron. The chronic or insidious type pursues a vague, mild course which must be differentiated from blood dyscrasias and other causes of anemia.

The roentgen findings of pulmonary hemorrhage are multiple blotchy, rapidly clearing shadows which vary in location and detail, but have the same general appearance. After repeated episodes of bleeding, a fine reticulostriate pattern ultimately develops. The hilar lymph nodes may appear enlarged on the roentgenogram and such enlargement has been confirmed at necropsy.

The authors believe that the underlying cause of this condition is a hypersensitivity state (see also Steiner: Arch. Dis. Childhood **29:** 391, 1954).

Ten roentgenograms; 7 photomicrographs.

PAUL MASSIK, M.D.
Quincy, Mass.

**Kartagener's Syndrome in a Newborn Infant.** Samuel J. Nichamin. J.A.M.A. **161:** 966–968, July 7, 1956. (672 Maccabees Bldg., Detroit 2, Mich.)

Kartagener's syndrome, consisting of situs inversus, sinusitis, and bronchiectasis, is well known. The author reports in detail the case of an infant who began to have respiratory distress thirty-three hours after an uneventful labor followed by low-forceps delivery. Cyanosis and dyspnea with tachypnea followed by a purulent nasal discharge soon appeared. Roentgenograms showed situs inversus, and a diagnosis of Kartagener's syndrome was made. After a stormy course, necessitating oxygen administration, the infant progressed satisfactorily. Recurrent respiratory infection over the succeeding months was energetically treated with antibiotics.

At two and half years, study of the chest, including bronchography, failed to reveal the presence of bronchiectasis even though the ethmoidal and maxillary sinuses were opacified with retained secretions. In addition, the nasal cavity was obstructed, presumably by polyps.

Since the percentage of bronchiectasis in the reported cases of the syndrome runs below 20 per cent, it is quite possible that prevention of involvement of the bronchial tree may be achieved in similar cases in which the diagnosis is made in early infancy. Constant antibiotic prophylaxis or appropriately vigorous antibiotic therapy for respiratory infections may well prevent dilatation of the bronchi.

Five roentgenograms.

SAUL SCHEFF, M.D.
Boston, Mass.

**Branchiogenic Intrathoracic Mediastino-Thymic Cyst.** Z. V. Skokan and J. Stolz. Radiol. clin. **25:** 266–273, July 1956. (In German) (A. Letenské 6, Prague, XII, Czechoslovakia)

Branchial cysts in the neck are common; those within the chest are rare. The authors report an example of the latter in a ten-year-old boy who was examined radiographically after an attack of the grippe. Standard radiography, supplemented by stratigraphy and kymography, demonstrated a sharply outlined rounded structure 4 cm. in diameter in the anterior mediastinum, lying directly on the heart shadow. The preoperative diagnosis was cyst. The location excluded a pericardial or gastroenteric cyst.

Microscopy revealed a system of cysts arising in the development of thymus tissue from the third branchial arch. In addition to the thymus tissue there was found a cyst lined with stratified squamous epithelium and a cylindrical, frequently stratified, respiratory epithelium with glands of the respiratory membrane. Essentially, one was dealing with a dysgenetic hamartoma of the thymus in the anterior mediastinum.

Four roentgenograms; 6 photomicrographs.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Experimental Staphylococcic Bullous Pneumopathy.** R. Herbeuval and G. Debry. J. franç. de méd et chir. thorac. **10:** 241–270, 1956. (In French)

The authors injected a suspension of staphylococci intravenously into 300 rabbits in order to study the visceral lesions produced, especially the pulmonary lesions. Subpleural and intraparenchymal blebs and bulla formation were studied extensively. Some of the rabbits were allowed to die of the infection, while others were sacrificed during the course of the disease.

Some of the cavity-like lesions were seen as clearly demarcated excavations surrounded by a narrow necrotic band. Others appeared first as solid areas, with later excavation, and some were surrounded by inflammatory changes in the lungs.

One mechanism of bleb formation appeared to be edema of the bronchial mucosa giving rise to a valvular action. After the edema subsided the cavitary lesion apparently disappeared.

It is difficult to explain the more frequent appearance of this phenomenon in children. It is postulated that the smaller bronchi may be partially occluded more easily than in adults and that the elasticity of the chest allows the valvular action to expand the bleb readily. It is also suggested that the staphylococcic toxin may irritate the neurovegetative system, which in turn affects the bronchi and small blood vessels of the lung in such a manner as to enhance bleb formation.

CHARLES M. NICE, JR., M.D., PH.D.
University of Minnesota

## THE CARDIOVASCULAR SYSTEM

**The Growing Importance of Cardiovascular Radiology.** Fred Jenner Hodges. New England J. Med. **255:** 28–35, July 5, 1956. (University Hospital, Ann Arbor, Mich.)

Although earlier work had been published on cerebral angiography, abdominal aortography, cardiac catheterization, venography, and peripheral arteriography, it was not until the visualization of the cardiac chambers by Robb and Steinberg in 1938 that the intensive use of contrast study of the cardiovascular system received its great impetus. Since then progress has been rapid, with the development of safer opaque media, new means of rapid injection, timing devices, electronic image amplifiers, and, not least, great advances in cardiovascular surgery.

Venography is now used not only to visualize the veins in a tourniquet-occluded extremity but in the study of the venae cavae within the thorax and abdomen, the splenoportal system and the venous channels in the brain.

Arteries have been injected for direct study of their own status, as well as the vascular patterns of the organs they supply. A wide variety of conditions have been examined in this manner. Retrograde injection of the aorta has made possible demonstration and localization of the aberrant vessel leading to a lung sequestration. Cerebral angiography often indicates the presence, location, and occasionally the nature of a space-occupying lesion in the cranium and is less traumatizing than aerographic diagnosis.

Perhaps the most impressive of the newer procedures is the demonstration of the various chambers of the heart in a well timed angiocardiogram. Not only are congenital lesions detected, but vascular anomalies and acquired defects are often well shown.

Ten roentgenograms. SAUL SCHEFF, M.D.
Boston, Mass.

**Intracardiac Angiography: Controlled Instantaneous Intra-Atrial Release of Contrast Material in Man.** Bernard L. Brofman. J. Thoracic Surg. **32:** 28–34, July 1956. (Mt. Sinai Hospital, Cleveland, Ohio)

This communication is a preliminary report of the author's experience with a method which provides controlled instantaneous release of large volumes of contrast material within the right atrium. The procedure was designed to obviate the difficulties encountered in attempting rapid intravenous injection of relatively viscous contrast media in adults. The method has proved to be safe and practical for most clinical applications. A specially designed balloon-tipped cardiac catheter is advanced intravenously until the tip is passed into the right atrium and just into the inferior vena cave. The position of the catheter is checked with a small volume of contrast material, following which 40 to 50 c.c. of the medium (70 per cent Diodrast) is injected rapidly into the balloon. One second after x-ray exposure is begun, a pull is exerted on a wire connected with the balloon. This pulls down the cuff holding the proximal end of the balloon, resulting in sudden liberation of the contained solution.

In the 5 patients studied, satisfactory films were obtained, and the rapid liberation of the material produced no adverse effects. This appears to be a safe and effective method for achieving adequate visualization for angiocardiographic purposes.

Seven illustrations. THEODORE E. KEATS, M.D.
University of Missouri

**The Angiocardiographic Diagnosis of Left Atrial Thrombosis.** Louis A. Soloff and Jacob Zatuchni. Circulation **14:** 25–32, July 1956. (L. A. S., 255 S. 17th St., Philadelphia 3, Penna.)

The authors report what they believe to be the first cases of left atrial thrombosis to be diagnosed by angiocardiography. They found 5 examples in 57 examina-

tions. Two of these were verified surgically and 1 at autopsy.

The left atrium is believed to be particularly suitable for angiocardiographic demonstration of thrombi. Any mass attached to its walls is easily visible, provided overlapping structures are eliminated and the projection is adequate. A left lateral view is best, since only in this projection is the extreme posterior wall of the left atrium visible and it is from this wall that the left atrial mural thrombus almost always arises.

Mural thrombi are indicated by irregular filling defects along the posterior wall; the ball-valve type by a spherical filling defect not touching the atrial wall; and auricular thrombosis by irregular margination of the junction of the auricle and atrium, with little or no visualization of the auricle. Cardiac tumors are differentiated by their larger size; they are attached, as a rule, to the atrial septum in the region of the fossa ovalis.

Seven roentgenograms, with accompanying drawings; 1 photograph.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**The Diagnosis of Congenital Heart Disease in Infants by Catheterization and Selective Angiocardiography.** Ib Boesen, John Lind, B. Merrild-Hansen, Th. Rosendal, Ole Storm, and Carl Wegelius. Brit. Heart J. **18:** 355–364, July 1956. (I. B., Dronning Louises Børnehospital, Copenhagen, Denmark)

Diagnosis of congenital heart disease is considerably more difficult in infants than in adults. This is due to a number of factors: many more types of disease occur; the x-ray appearances at this age are often not characteristic; fluoroscopy is difficult because of lack of cooperation, physiological tachycardia, and a frequently overlapping thymus shadow. The authors present a logical extension of available diagnostic procedures which in their hands has yielded more precise information for the surgeon.

Cardiac catheterization is carried out in the usual manner but, while the catheter is still in place, an opaque medium is injected under pressure in small amounts and rapid biplane angiocardiography is done. Overlapping shadows and dilution are thus avoided. Fifty cases are reported, with no undue incidence of complications attributable to the procedure.

[One more extension would seem indicated when generally available—the use of ultra-fast exposures from the "switch tube."—Z.F.E.]

Twenty-four roentgenograms; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**The Importance of the Translumbar Aortogram and Peripheral Arteriogram in the Management of Vascular Disease.** Andrew G. Sharf, Emory H. Anderson, Earle D. Acker, and Arthur J. Thielen. West. J. Surg. **64:** 394–401, July 1956. (A. G. S., 922 S. Central Ave., Glendale 4, Calif.)

Vascular surgery has become quite dependent on aortography and peripheral arteriography both preoperatively and postoperatively. In occlusive disease, both acute and chronic, opacification of the arteries is of importance in determining the site of occlusion, type of operation, and indeed whether any surgery is indicated. Arteriography gives the most accurate estimate of the damage to the vessels in severe crush injuries to the extremities. Aneurysms and congenital and acquired arteriovenous fistulae are self-evident indications for the procedure. Postoperatively the status of grafts or prostheses can be evaluated when there is doubt about the results of surgery.

Technic is discussed [nothing new] and 10 representative cases are well illustrated.

Eleven roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Transcarotid Aortography.** Patrick Crawford, William Molnar, and Karl P. Klassen. J. Thoracic Surg. **32:** 46–52, July 1956. (Ohio State University Health Center, Columbus, Ohio)

A method of transcarotid thoracic aortography which has given excellent visualization of the entire thoracic aorta is described. The contrast medium (70 per cent Diodrast) is injected rapidly into the ascending aorta just above the aortic valve by means of a large, short catheter inserted through the exposed right common artery. Intimal damage to the aorta and carotid artery due to the presence of the catheter or contrast medium is negligible because of the large size of these vessels and the rapid flow of blood in this region. Cerebral vessel filling can be kept to a minimum by occlusion of both common carotid arteries at the time of contrast injection.

Seven roentgenograms; 2 photographs.

THEODORE E. KEATS, M.D.
University of Missouri

**An Angiopulmographic Study of the Lesser Circulation in Mitral Stenosis.** A. Actis-Dato, P. F. Angelino, and A. Brusca. Am. Heart J. **52:** 1–6, July 1956. (A. A.-D., Clinica Chirurgica della Università di Torino, Torino, Italy)

The authors studied the morphologic appearance of the pulmonary vessels in 500 patients with mitral stenosis, 250 of whom underwent mitral commissurotomy. They found that the main pulmonary artery and the right and left branches are more or less enlarged in all cases. The medium-sized and smaller vessels show morphologic changes in varying degrees; they may or may not be enlarged, and there may or may not be changes in the general anatomical appearance. Enlargement of the venous channels is manifest as irregularly shaped dots and striae throughout the lungs.

The authors divide their cases into three groups, depending upon the morphology of the vessels and the delay of the contrast substance in the circulation. In the *first group*, the arterial circulation is only slightly delayed, and stasis in the pulmonary veins and left atrium are the main features. The pulmonary arteries may be moderately enlarged, but without morphologic alteration in appearance. In the *second group*, the arterial circulation is delayed, as is emptying of the right heart. The main pulmonary arteries are enlarged, while the smaller arterial vessels show abrupt narrowing, a tortuous course, and indistinct, irregular borders. The peripheral vessels appear as a coarse reticulum. In the *third group*, there is prolonged stagnation of the contrast substance in the right heart and pulmonary artery. The right and left pulmonary arteries are markedly dilated. The medium-sized arterial vessels show a sharp narrowing or even an amputated appearance. The peripheral portions of the lungs are poorly vascularized.

The angiopulmographic picture corresponded fairly well with the clinical and hemodynamic status of the

patient, and the procedure is considered a useful adjunct for the evaluation of patients undergoing mitral commissurotomy.

Sixteen roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

**The Relation of Pectus Excavatum to Heart Disease.** Fred W. Wachtel, Mark M. Ravitch, and Arthur Grishman. Am. Heart J. **42:** 121–137, July 1956. (F. W. W., Department of Surgery, Mt. Sinai Hospital, New York, N. Y.)

Pectus excavatum, or funnel chest, is a congenital, deformity consisting of dorsal displacement of the sternum, which may result in disturbances in cardiorespiratory physiology. Some authors claim that this deformity can be observed at birth, with the first few respirations.

Theories proposed to explain the anomaly are: deficiency in the musculature of the anterior half of the diaphragm due to an arrest in development; a neuromusculature imbalance, with over-stimulation of the anteroposterior fibers of the diaphragm; shortening of the anterior tendon of the diaphragm; overgrowth of the ribs; a defect in connective tissue, suggested by association of the deformity with Marfan's syndrome (arachnodactyly, spider fingers). All agree that the primary defect involves the anterior chest wall and is operative during the years of growth and development, for which reason secondary changes involving the spine, the paravertebral musculature, and the thoracic viscera are prone to develop. The thoracic volume is decreased, with variable degrees of compression and rotation of lungs, heart, mediastinum, and great vessels.

Because of the encroachment of the sternum on the retrosternal space, the roentgenographic examination of the chest usually shows displacement of the cardiac silhouette in the left hemithorax. In some cases there is extension of the heart shadow not only to the left, but to the right as well. In some the right cardiac border is obscure, apparently falling within the projection of the spine. In these there may be an elevation of the cardiac apex above the diaphragm, associated with a prominent and long main pulmonary artery segment. In the lateral projection the anteroposterior diameter of the heart is small; the extent of the sternal depression can be demonstrated with the aid of barium paste on the skin surface.

The authors' experience covers 50 cases. The present report is based upon 13 cases studied since 1952, of which 11 were treated surgically. Patients were referred because of cosmetic appearance, suspicious murmurs, or cardiac symptomatology. The clinical picture, electrocardiographic and vectorcardiographic findings are considered. Preoperative cardiac catheterization was done in 2 adult patients, whose histories are included.

The authors believe that, when symptoms are present, they are the result of altered function of the cardiorespiratory system and that relief can be afforded by surgery. Circulatory embarrassment is caused by (1) cardiac rotation with twisting and kinking of the great veins, impeding the return of blood flow to the right heart; (2) cardiac impingement, especially on the atria, resulting in arrhythmias and involvement of A-V conduction; (3) restriction of expansion of the heart; (4) a decrease of respiratory reserve because the intercostal component of respiration is impaired.

Eight roentgenograms; 2 photographs; 2 electrocardiograms; 2 vectorcardiograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

**Absence of the Left Pulmonary Artery in Fallot's Tetralogy.** Richard W. Emanuel and J. Norman Pattinson. Brit. Heart J. **18:** 289–295, July 1956. (Middlesex Hospital, London, England)

Absence of a pulmonary artery is an uncommon but important anomaly sometimes seen in association with tetralogy of Fallot. In the presence of this complication the Blalock operation cannot be performed and direct aortopulmonary anastomosis must be done.

The authors found in the literature 18 cases of absence of the pulmonary arteries associated with Fallot's tetralogy and add 2 cases of their own. In 17 cases it was the left artery which was missing, and in the single exception, in which the right vessel was absent, there was a mirror-image dextrocardia. In a group of 19 cases studied for comparison, in which no embryological defect occurred in the bulbus cordis, but with absence of a pulmonary artery, it was nearly always the right artery that was missing (17 out of 19). This difference is explained on an embryologic basis.

In this group of cases of Fallot's tetralogy the incidence of right aortic arch was considerably higher than is usual in that condition, *i.e.*, 60 per cent (12 out of 20) as compared to 20–25 per cent in patients without absence of the artery (Taussig).

In one of the authors' cases the diagnosis was made by angiocardiography, but in the other enough opaque medium reached the lung periphery to make it appear as if both arteries were present. At surgery the left artery was found to be completely absent, the medium having reached the lungs by way of bronchial and intercostal collaterals. [The point is not made by the authors, but the age difference might account for the presence of collaterals in the second case (17 years) and their absence in the first (6 years).—Z.F.E.]

One roentgenogram; 4 drawings.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Anomalous Pulmonary Venous Drainage.** John B. Hickie, T. M. D. Gimlette, and A. P. C. Bacon. Brit. Heart J. **18:** 365–377, July 1956. (St. Thomas' Hospital, London, England)

Total anomalous pulmonary venous drainage gives a characteristic radiographic appearance, with the "figure-of-eight" silhouette, but incomplete drainage into the systemic veins presents a much more difficult problem in differential diagnosis. Thirteen cases are described.

The fundamental disturbance in anomalous pulmonary veins is similar to that found in an atrial septal defect, namely recirculation of oxygenated blood through the lungs. This increased pulmonary flow causes enlargement of the right atrium, right ventricle, and pulmonary artery and may in time cause raised pulmonary arterial and right ventricular pressures. Symptoms probably do not arise unless the anomalous drainage involves at least the whole of one lung (50 per cent or more of the pulmonary flow), or is associated with an atrial septal defect, or is part of a more complicated anomaly. Single anomalous veins are usually asymptomatic.

The changes in the shape and size of the heart are

demonstrable radiographically but are of little value in differentiating this condition from other lesions causing a left-to-right shunt. The shadows produced by the anomalous veins present two characteristic pictures. (1) When the veins from the left, and possibly the right, lung enter a persistent left superior vena cava draining into the left innominate vein, the abnormal vessel may be seen to the left of the upper mediastinum as a homogeneous bulge, which may be observed on fluoroscopy to pulsate. As a consequence of the increased blood flow into the normal superior vena cava, this in turn dilates, it may also pulsate, and the abnormal vascular shadows in the superior mediastinum, together with the heart, form the characteristic "figure of eight." (2) Where there is anomalous drainage into the superior or inferior vena cava, the aberrant vessel itself may be seen in the conventional chest film.

Of the authors' cases, only 1 showed an abnormal superior vena cava, which returned to normal after ligation of the pulmonary artery to the involved right upper lobe. In another case, with pulmonary edema from mitral stenosis, the left upper lobe was not involved by the edema because its vein drained into a left superior vena cava and hence did not share in the raised pressure of the left atrium. (This finding does not appear to have been described previously.)

Cardiac catheterization was done on 12 patients. The catheter may enter an anomalous vein or may show evidence of a left-to-right shunt. When the catheter does not enter an anomalous vein, it is difficult to differentiate the condition from atrial septal defect and, indeed, they are often associated. Angiocardiography was not used in this series.

Surgically the treatment is not standardized, including such procedures as ligation of the vein or artery, lobectomy or pneumonectomy, and procedures aimed at redirecting the flow of blood into the correct chamber.

Five roentgenograms; 3 drawings; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Posteroanterior Chest Roentgenogram in Two Types of Anomalous Pulmonary Venous Connection.** André J. Bruwer. J. Thoracic Surg. **32:** 119–134, July 1956. (Mayo Clinic and Mayo Foundation, Rochester, Minn.)

The author presents several cases which illustrate the two types of anomalous pulmonary venous connection which are readily recognizable on the routine postero-anterior chest roentgenogram.

In one type all of the blood of both lungs drains to the right superior vena cava by a partially persistent left superior vena cava or left vertical vein. This is the so-called "figure-of-eight" type of total anomalous pulmonary venous connection. It is obvious that, if there is no atrial septal defect, the condition is incompatible with life for more than a short time. In these cases, the lung fields will show marked engorgement, since the systemic and most of the pulmonary venous blood will recirculate through the lungs. The principal roentgenologic finding in these cases is the figure-of-eight configuration of the cardiac silhouette. Fluoroscopically, the upper part of the shadow, which is composed of the left and right superior venae cavae will show a gentle pulsation, whereas pulsation in the pulmonary trunk and its branches may be considerably exaggerated as compared to normal. The second type is that in which part or all of the blood from the right lung drains into the inferior vena cava. In this type, the anomalous vein can frequently be distinguished close to the right cardiac border. Near the diaphragm, it becomes a single trunk, having collected branches as high as the apex of the right lung. This is best demonstrated by tomograms. Usually the heart will present prominently in the hemithorax, which is probably a reflection of the enlarged right atrium, this chamber receiving more blood than under normal conditions. In some cases, however, the venous anomaly is accompanied by hypogenesis of the right lung, and in that event it may be natural for the heart to shift into the right hemithorax.

These cases are of interest in that they are in the realm of surgical correctability.

Fifteen roentgenograms; 4 drawings.

THEODORE E. KEATS, M.D.
University of Missouri

**Clinical Manifestations of the Unperforated Aortic Sinus Aneurysm.** Israel Steinberg and Nathaniel Finby. Circulation **14:** 115–124, July 1956. (New York Hospital-Cornell Medical Center, New York, N. Y.)

In 2,500 angiocardiographic examinations in ten years, the authors found 19 unruptured aortic sinus aneurysms, 10 syphilitic and 9 congenital. Analyzing these cases in retrospect, they find few features beside the angiocardiograph which permit clinical diagnosis of this condition.

There were associated anomalies in all of the congenital group: 4 patients had coarctation of the aorta, 1 a pseudo-coarctation, and 1 congenital mitral and aortic stenosis with generalized hypertrophy of the cardiac chambers. Three had the classic findings of arachnodactyly. In all there were loud systolic murmurs to the left of the sternum.

In the cases of syphilitic etiology there was evidence of aortitis, aortic incompetence, aneurysm of the aorta itself, or calcification of the ascending portion, sometimes extending down into the cardiac shadow.

In both groups the sinus aneurysm was seen on angiocardiograms, best in the left anterior oblique position. Aneurysms of syphilitic origin were much larger than the congenital ones, sometimes producing pressure effects by their size.

As to treatment, the authors believe it might be feasible to approach a small localized congenital aneurysm through the right atrium, but repair of the diffuse congenital or the syphilitic types seems to be impossible.

Six roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Michigan

**Contrast Medium Injury to the Spinal Cord Produced by Aortography. Pathologic Anatomy of the Experimental Lesion.** G. Margolis, A. K. Tarazi, and K. S. Grimson. J. Neurosurg. **13:** 349–365, July 1956. (Duke University School of Medicine, Durham, N. C.)

In this paper the authors consider the anatomic features of cord injuries produced in dogs by the rapid intra-aortic injection of contrast media as described in an earlier paper (Tarazi *et al.*: Arch. Surg. **72:** 38, 1956. Abst. in Radiology **67:** 776, 1956). A severe destructive effect productive of extensive myelomalacia was encountered. These findings indicate that the previous concept of the contrast medium injury as a

transitory disturbance of the blood-brain barrier is inadequate. This extension of knowledge has been possible, because the site of injury allowed extended survival of the experimental animals, and an opportunity to study the complete evolution of the lesion.

The supine position during injection favors production of spinal cord injury by a contrast medium, because this position favors filling of the dorsal branches of the aorta.

The sharply marginated malacic lesions, closely corresponding to specific blood supply zones, are best explained as a result of the primary sweep of a toxic concentration of the contrast medium through the spinal cord circulation. The evidence points to a direct action on neurones, and indicates that the injury is not entirely the result of ischemia.

These studies show that the canine spinal cord is an ideal structure for testing the toxic effects of contrast material on the nervous system.

Fourteen illustrations.

THEODORE E. KEATS, M.D.
University of Missouri

**Transventricular and Aortic Angiocardiography and Physiologic Studies in Dogs with Experimental Mitral and Aortic Insufficiency.** Robert J. Wilder, Howard L. Moscovitz, and Mark M. Ravitch. Surgery **40:** 86–99, July 1956. (R. J. W., Baltimore City Hospitals, Baltimore, Md.)

Visualization of the left heart chambers and aorta in dogs with surgically produced mitral and aortic valvular lesions was carried out by means of direct ventricular puncture and retrograde aortic catheterization. The degree of aortic or mitral regurgitation demonstrated roentgenographically correlated with the change in the pressure tracings of the left heart chambers. The roentgen contrast technic is unusually sensitive and detects small volumes of regurgitated material at a time when the pressure studies may fail to show anything but a minimal change. Maximum opacification of the left atrium is quickly achieved as the degree of insufficiency increases, however, and further increase in the amount of regurgitation does not significantly alter the density of the left atrium. On the other hand, while left atrial pressure tracings frequently fail to reveal minimal degrees of reflux, they clearly reflect progressive increases in the amount of regurgitation. With large degrees of insufficiency, the left atrial curve becomes a more valuable guide in quantitative estimation of the reflux than the contrast roentgenogram.

A stenosing ligature passed below the mitral annulus definitely diminishes but does not obliterate the regurgitation through the mitral valve and is associated with the appearance of an elevated left atrioventricular filling pressure gradient.

Contrast visualization of lesions of the aortic valve by the retrograde catheter technic is relatively simple. Free reflux of the medium into the left ventricle occurs when aortic insufficiency is present. When a wide aortic pulse pressure is found there is usually no difficulty in the clinical diagnosis of aortic insufficiency. However, from these studies it can be seen that the superimposition of aortic stenosis upon insufficiency narrows the aortic pulse pressure and obscures its characteristic pattern. This occurs despite the fact that regurgitation of contrast material into the left ventricle still takes place.

While the manner in which mitral and aortic stenosis and insufficiency was simulated in these experiments does not duplicate the anatomic lesion as it occurs in the diseased state, the dynamic feature of free retrograde reflux through an incompetent valve has been retained and the observations made in these experimental studies may be correlated, to a significant degree, with valvular disease in man.

Fourteen roentgenograms; 8 pressure tracings; 3 photographs.

## THE BREAST

**Can Mass X-Ray Surveys Be Used in Detection of Early Cancer of the Breast?** J. Gershon-Cohen, Helen Ingleby, and Lolita Moore. J. A. M. A. **161:** 1069–1071, July 14, 1956. (Albert Einstein Medical Center, Northern Division, Philadelphia, Penna.)

The authors advocate the use of serial survey x-ray studies to detect early neoplasms of the breast in women over thirty-five, not as a replacement of biopsy but rather as a guide to indicate the proper time and site for the tissue study of small, clinically undetectable lesions or those occurring in a nodular breast.

Carcinoma of the breast may assume any of the following radiographic appearances. (1) With scirrhus carcinoma the tumor opacity shows tentacles and spiculated margins, loss of normal architecture, and infiltration of surrounding tissue. (2) In a medullary carcinoma the tumor mass is more or less sharply defined, but closer examination reveals some tentacles and spicules from a portion of the circumference. Punctate calcification within the mass may indicate an adenopapillary carcinoma, while coarse and flaky calcification may be a sign of advanced mucoid degeneration. The roentgenographic appearance in both (1) and (2) is deceiving inasmuch as the resected lesion is usually larger than it appears on the film. (3) Numerous punctate calcific deposits along the course of the ducts indicate an intraductal (comedo) type of carcinoma.

Secondary signs of breast cancer may appear: nipple retraction or displacement, intraction or thickening of the skin, thickening of the fibrous trabeculae, and increased vascularity around the tumor.

Preclinical lesions should be suspected when the film shows an area of punctate calcification or an ill-defined shadow that has no correspondence in the contralateral breast.

In the differential diagnosis, the density of the carcinoma with its irregular infiltrating margins is contrasted with the smooth, regular opacity of the adenofibroma or cyst. Punctate calcification should always be regarded with suspicion and lead to biopsy even though it may occur in benign ductal hyperplasia. In questionable cases, serial studies will not only differentiate stationary tumors from active hyperplasia but will also indicate the optimum time for biopsy. Since intraductal hyperplasia, recognized by the scattered punctate calcification, is an indication of abnormal reaction to hormonal stimulation and thereby a precancerous lesion, long-term serial roentgen study could replace serial biopsies and point up the optimal site and more propitious time for histologic study of the suspected area.

Five roentgenograms; 1 photomicrograph.

SAUL SCHEFF, M.D.
Boston, Mass.

## THE DIAPHRAGM

**Surgery of Eventration of the Diaphragm.** E. F. Chin and R. B. Lynn. J. Thoracic Surg. **32:** 6–14, July 1956. (E. F. C., Thoracic Surgical Unit, Southampton, England)

Eventration of the diaphragm is a congenital abnormality resulting from failure of muscularization of the diaphragm. The condition may be localized or the whole dome may be involved, in which case the diaphragm is represented by a thin membrane attached peripherally to normal muscle. In true eventration, the phrenic nerve appears normal and the muscular portion of the diaphragm contracts vigorously on faradic stimulation of the nerve and by its contraction pulls down the maldeveloped portion. The authors review 38 cases.

In the newborn, eventration may cause death from cardiorespiratory failure due to inadequate oxygenation because of impaired diaphragmatic movement. Cardiac displacement may also be present, adding to the child's difficulties. Beyond infancy, the condition tends to remain symptomless until adult life, when increasing weight and raised intra-abdominal pressure may produce symptoms, usually gastrointestinal in nature but sometimes including respiratory embarrassment and even cardiac distress.

The radiographic findings consist of conspicuous elevation of the diaphragm, which presents a smooth unbroken curve, said to be one of the cardinal diagnostic features of complete eventration. If the defect is localized, a cystic shadow may be reported. In all cases studied fluoroscopically, the diaphragm was mobile, though often limited in its range of motion.

A barium-meal examination is frequently diagnostic and may demonstrate the stomach rolled up-side down, with the splenic flexure alongside, beneath the intact dome of the diaphragm. There is no reflux of barium up the esophagus in the Trendelenburg position. The only condition with which eventration could be confused is a hernia through the dome of the diaphragm.

The authors report 5 cases treated successfully by surgery. When the defect is localized, treatment consists in resection of the membrane and suturing of the muscular components. When the whole dome is involved, complete mobilization of the muscular component can be carried out and, after resection of the affected portion, muscle-to-muscle suture can be performed. No reinforcement such as tantalum mesh or fascia lata graft is necessary.

Nine roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

## THE DIGESTIVE SYSTEM

**Co-Occurrence of Large Leiomyoma of the Esophagus and Squamous-Cell Carcinoma of the Thymus. Report of a Case, with Roentgenologic, Pathological and Clinical Discussion.** Howard A. Frank, Leopold Reiner, and Felix G. Fleischner. New England J. Med. **255:** 159–164, July 26, 1956. (Harvard Medical School, Boston, Mass.)

The authors present a case of hugh leiomyoma of the esophagus with extensive calcification, developing along with a carcinoma of the anterior mediastinum which is thought to have arisen in the thymus.

The esophagus is the least common location in the gastrointestinal tract for leiomyomas in general; in particular it is an uncommon location for leiomyomas with marked calcification. Indeed, spindle-cell tumors of the gastrointestinal tract as a group are not often calcified, although the larger the tumor the greater the likelihood of central necrosis and calcification. In the case reported here the tumor was presumably present for at least sixteen years before surgical intervention. The direction of growth was almost completely extramural, and the appearance on the roentgenogram was that of a soft-tissue mass occupying the posteroinferior mediastinum and extending into the left side of the chest. In a period of eight years it showed little change except for an increase in calcification. Later chest films revealed the presence of the rapidly growing thymic tumor in the anterior mediastinum. Both growths were successfully removed and diagnosed histologically.

Three roentgenograms; 2 photographs; 6 photomicrographs. JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

**Achalasia of the Cardia and Mega-Esophagus. Report of Five Representative Cases.** Charles H. Brown and C. Peter Albright. Cleveland Clin. Quart. **23:** 186–199, July 1956. (C. H. B., 2020 E. 93rd St., Cleveland 6, Ohio)

Achalasia, or failure of relaxation of the musculature at the lower end of the esophagus, is of unknown etiology. It leads to varying degrees of esophageal enlargement (mega-esophagus). The dilatation may be so great that a roentgen diagnosis can be made from a chest film. A barium swallow will show the esophagus tapering to a smooth constriction at the level of the hiatus, a finding which is characteristic. Fluoroscopy usually reveals an atonic dilated esophagus with weak tertiary waves and no primary peristalsis. The treatment is essentially medical, with dilatations of the cardiac sphincter, bland diet, and supportive measures. Five cases are reported.

Nine roentgenograms.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

**A Malabsorption Syndrome in Military Personnel in Puerto Rico.** Frank H. Gardner. Arch. Int. Med. **98:** 44–60, July 1956. (Peter Bent Brigham Hospital, Boston, Mass.)

The author describes a malabsorption syndrome observed in military personnel stationed in Puerto Rico, characterized by weight loss, diarrhea, dyspepsia, and lassitude. None of the patients were anemic. Laboratory studies indicated poor absorption of glucose, D-xylose, vitamin A, and butter fat. The majority of the patients responded well to oral folic-acid therapy. These cases are in contrast to the usual form of tropical sprue, in that these patients did not have megaloblastic bone marrow changes with macrocytic anemia.

In 17 (80 per cent) of the present series of 21 cases, the roentgen findings in the small bowel were abnormal. The changes noted were dilatation, thickened folds, segmentation of the barium meal, and scattering of residual barium. The author was able to find no good correlation between the initial x-ray examination and results of the oral glucose tolerance test. Four patients had no abnormalities in the small bowel pattern despite the presence of impaired oral absorption of butter fat, vitamin A, glucose, and D-xylose.

Abnormal small bowel patterns showed a tendency to revert to normal or to improve after folic-acid therapy.

At present there is no explanation for this malabsorption syndrome.

Seven roentgenograms; 3 charts; 4 tables.

THEODORE E. KEATS, M.D.
University of Missouri

**Roentgenologic Findings of Small Intestine in 100 Repatriated Prisoners of War. Deficiency States and Worm Infestations.** Walter Francke. Am. J. Roentgenol. **76:** 149–152, July 1956. (St. Vincent Hospital, Billings, Mont.)

Small bowel x-ray studies were performed on 100 prisoners of war shortly after their release from North Korea. Dietary deficiency states of various degree were present and 80 per cent of the men had intestinal roundworm infestations (*Ascaris lumbricoides*). The findings are reviewed and discussed.

The *Ascarides* characteristically produced sharply defined, coiled or linear filling defects, up to 20 cm. long, within the intestinal lumen. Barium was sometimes present within the enteric canal of the worm, and sometimes adherent to its surface. The worms were believed to cause no change in small bowel mucosal pattern.

The deficiency state was apparently responsible for segmentation of intestinal loops, clumping of barium, alternate areas of dilatation and contraction of the bowel, thickening of mucosal folds, and loss of haustral markings.

Small bowel transit time was slightly increased in almost all patients.

As a result of his experience, the author feels that roentgen examination is more reliable for diagnosing roundworm infestation than stool examinations for ova or eosinophilic blood cell counts.

Seven roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Postbulbar Peptic Ulceration of the Duodenum.** Robert F. Rauch. Ann. Surg. **144:** 57–66, July 1956. (Ohio State University College of Medicine, Columbus, Ohio)

Postbulbar duodenal ulcer is a fairly well defined entity distinct from its counterpart in the more proximal duodenum. Clinically the response to an ulcer regime is less satisfactory than in bulbar ulcerations. Hemorrhage is common, and the usual location of the ulcer on the posterior or medial wall means that the pancreas is likely to be invaded, in which event the clinical picture may be that of pancreatitis. Obstructive jaundice has been reported but is unusual, as is actual obstruction of the duodenum.

Postbulbar ulcers may occur in conjunction with bulbar involvement but are frequently seen alone, with the bulb itself normal. The common roentgen finding is an ulcer niche. More characteristic, however, is a constant constriction of the duodenal lumen at the ulcer site, easily diagnosable if the condition is kept in mind and the examination carried past the bulb.

Fourteen cases are tabulated, 7 of which are reported in detail. The diagnosis was missed roentgenologically one or more times in 4 of 12 patients examined. Surgical procedures gave just as satisfactory results as in ordinary ulcers. The authors caution, however, against trying to remove the ulcer bed itself when it is past the superior flexure of the duodenum, because of possible biliary tract damage.

One table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Lymphosarcoma of the Large Bowel.** Martins da Silva. Gaz. méd. portuguesa **9:** 467–472, July-August 1956. (In Portuguese) (Serviço de Radiologia do Hospital de Curry Cabral, Lisbon, Portugal)

In reporting the case of a 26-year-old male with lymphosarcoma of the colon, diagnosed by histologic examination of the surgical specimen, the author recalls that this neoplasm may cause a palpable, tender, at times spontaneously painful abdominal tumor, with melena (anemia, loss of weight) and perhaps episodes of intussusception (visible peristalsis, vomiting, diarrhea). In the order of frequency, metastases occur to (*a*) the lymph nodes (mesenteric, retroperitoneal, epiploic, mediastinal, inguinal, axillary), (*b*) liver, (*c*) kidneys, (*d*) spleen, (*e*) pancreas, and (*f*) lung. Expected roentgen findings are (1) partial or complete obstruction of the colonic lumen; (2) an annular or parietal filling defect; (3) dilatation of the lumen in the area of the tumor, a sign particularly well demonstrated on progress examinations made at intervals of as little as twenty days; (4) prestenotic dilatation; (5) rarely, colonic intussusception (colocolic, cecocolic, ileocolic, or ileocecocolic).

Two roentgenograms.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

**Acute Pancreatitis. Preliminary Investigation of a New Radiodiagnostic Sign.** Charles Stuart. J. Fac. Radiologists **8:** 50–58, July 1956. (Fremantle Hospital, Perth, Western Australia)

A new radiographic sign for acute pancreatitis is here presented, along with a review of the literature and reports of 6 illustrative cases. This new sign, called the transverse colon "cut-off" sign, appears to be one of the more dependable and characteristic of the many radiographic findings associated with the disease. It is caused by mechanical change and edema in the transverse colon and transverse mesocolon, which are closely adjacent to the head of the pancreas.

Normally, the abdominal plain film shows most of the colon outlined by gas or feces. The transverse portion can invariably be seen crossing the mid-line, even in conditions likely to be confused clinically with pancreatitis, such as perforation of a peptic ulcer or an obstructive lesion. In the presence of acute pancreatitis, there is a central segment of transverse colon which cannot be identified, and which is sharply "cut off" from the gas-filled hepatic and splenic flexure regions.

The author credits one of his surgical colleagues with discovery of the sign.

Nine roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Positional Relation of Gallbladder to Hepatic Flexure.** Harold G. Jacobson, Jerome H. Shapiro, Wilhelm Stern, and Maxwell H. Poppel. Am. J. Digest. Dis. 1 (n.s.): 294–300, July 1956. (Montefiore Hospital, New York 67, N. Y.)

In 384 of 405 cholecystograms in which an opacified gallbladder was visualized, a close relationship of that structure to the hepatic flexure was observed. In

257 cases the gallbladder was contiguous to the hepatic flexure, in 65 the distance between the two was from 1 to less than 2 cm., and in 62 from 2 to less than 3 cm. In only 21 cases (or 5 per cent) was the gallbladder considered to be "distantly removed." In the erect position the gallbladder was at times noted to move toward the mid-line, but even then it maintained a close proximity to the transverse colon. There generally was little if any change in the pre- and post-evacuation films of the colon as related to the gallbladder-hepatic flexure distance.

This positional relationship has practical significance in a roentgen study in that a diagnosis of cholelithiasis can be made with reasonable certainty on a scout film of the abdomen if calcareous structures are seen close to the hepatic flexure. Also, the search for a faintly opacified gallbladder in cholecystography can safely be concentrated around the hepatic flexure area.

Five roentgenograms; 1 table.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

**Delayed Visualization of the Gall Bladder Due to Gastric Retention.** S. A. Leader. Illinois M. J. **110:** 26–27, July 1956. (University of Illinois College of Medicine, Chicago, Ill.)

A case of delayed visualization of the gallbladder due to gastric retention is reported. Several hours following administration of Telepaque, a film revealed a large amount of the medium in the stomach, but none in the gallbladder. After a fatty meal, the contrast material disappeared almost completely from the stomach, and only a few flecks were seen in the colon. Seven hours later the gallbladder was faintly outlined; by the following day it was well visualized and appeared to be normal. Gastrointestinal study after an interval of several days showed only gastric retention.

The fact that delayed visualization or non-visualization of the gallbladder is not a necessary indication of gallbladder disease is emphasized. The importance of searching for gastric residues after cholecystography is noted.

Three roentgenograms.

**Residual Stone in the Biliary Ducts.** Frank B. Thomson. Surg., Gynec. & Obst. **103:** 78–84, July 1956. (University of British Columbia Medical School, Vancouver, British Columbia)

Residual stone in the common duct following cholecystectomy is a surgical problem of considerable magnitude. Surgical exploration greatly reduces the number of missed stones, but still is an incomplete method. In more than 10 per cent of patients so managed calculi are overlooked. The authors present a study of 39 proved cases in an attempt to determine the clinical characteristics of the occurrence and to determine how its incidence may be reduced.

The main clinical findings are postoperative recurrence of pain, observed in most of the cases, and jaundice with its associated laboratory abnormalities, in 70 per cent. Operative cholangiography before duct exploration, T-tube cholangiograms after exploration, and intravenous cholangiography postoperatively all are highly valuable in proving the diagnosis.

Operative cholangiograms shorten many operations because they eliminate unnecessary exploration of the common duct and often demonstrate unsuspected stones. In these 39 cases, cholangiograms done in the operating room after common duct exploration revealed residual stones in 10 cases. The surgeons read as negative the films in 4 patients in whom the roentgenologist later recognized stones. It was apparent that the stones may be multiple, and may be anywhere within the biliary tree.

The technic for operative cholangiography is outlined, and the author pleads for reading of the films in the operating room by the roentgenologist.

Nine roentgenograms; 3 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**New Techniques in Cholecystography.** L. Henry Garland. Minnesota Med. **39:** 433–439, July 1956. (450 Sutter St., San Francisco 8, Calif.)

This paper constitutes a general appraisal of cholecystography. The author's summary is as follows:

"Cholecystography, thanks in part to continuous chemical research and in part to improved roentgenologic technic, is undergoing steady improvement.

"The importance of proper preparation of the patient, correct dosage of opaque medium, regular sequences of roentgenographic exposures, and good roentgenologic technique is again stressed. To these, I would add critical examination of the roentgenograms under optimum conditions of transillumination, and joint consultation.

"The shadows of the biliary ducts are visible in a high percentage of post-cibum oral cholecystograms; attention to such shadows will permit the *preoperative* diagnosis of ductal stones and deformities more frequently than hitherto. When in doubt, immediate intravenous iodixamide may be used to supplement the oral study.

"Intravenous cholecystography is indicated in a very small percentage of patients, notably those with obstructive upper gastrointestinal lesions, moderate degrees of jaundice, or situational inability to co-operate with simpler and safer oral examinations.

"The great usefulness of nonsurgical cholangiography is stressed, especially in patients presenting diagnostic problems relative to the common bile duct. Roentgen conclusions concerning apparent disease involving the terminal portions of this duct ('stenosing papillitis,' 'sphincteric fibrosis,' et cetera) should be tempered by complete information as to the patient's concurrent medication. Drugs augmenting choledochal sphincter tone may produce transitory defects."

Five roentgenograms; 2 tables.

**A Comparative Study of the Newer Contrast Media Used in Cholecystography and Cholangiography.** Carl P. Wisoff and Benjamin Felson. Gastroenterology **31:** 20–32, July 1956. (B. F., Cincinnati General Hospital, Cincinnati, Ohio)

A comparison was made of Teridax, Telepaque and Cholografin with especial attention to their relative values in single and double doses, and to their efficiency in outlining the gallbladder and biliary ducts.

Seventy-seven patients were examined, and from two to four procedures were performed on each. Results may be summarized as follows:

1. In single doses Telepaque produced more radiodensity in the gallbladders than did Teridax.

2. The greater density did not mask stones when present.

3. Colonic residue in Telepaque examinations was not troublesome except for minor interference with gallbladder visualization in 4 of 73 cases.

4. Single doses of Telepaque seemed adequate for routine work. Repeat studies with double doses showed normal visualization in 5 cases which had initially shown faint or non-visualization.

5. Cholografin studies produced distinctly better duct visualization than did double-dose Telepaque examinations.

The authors suggest that cholangiography with Cholografin does not yield dividends sufficient to warrant routine performance prior to gallbladder surgery. They urge that search be continued for a more satisfactory intravenous medium.

Seven roentgenograms; 3 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Re-Evaluation of Fat-Free Preparatory Meal in Telepaque Cholecystography.** Walter M. Whitehouse. Am. J. Roentgenol. **76:** 21–23, July 1956. (University Hospital, Ann Arbor, Mich.)

Because Telepaque is more rapidly concentrated in the gallbladder and gives a denser gallbladder shadow, the author sought to determine whether, with the use of this preparation, a fat-free supper was necessary preparatory to cholecystography the following morning.

A study of 50 healthy volunteers was carried out, each of whom was examined by cholecystography with preliminary fat-free and fatty meals. There was definite evidence that better results were obtained with the fat-free meal, and its continued use is therefore justified.

Four roentgenograms; two tables.

PAUL MASSIK, M.D.
Quincy, Mass.

**Evaluation of the Cystic Duct Stump in Intravenous Cholangiography.** L. Fried. Fortschr. a. d. Geb. d. Röntgenstrahlen **85:** 47–54, July 1956. (In German) (Nefelejts-u. 42, Budapest VII, Hungary)

Following cholecystectomy the cystic duct stump can frequently be recognized with the aid of intravenous cholangiography. The size and shape of the residual duct depend (1) on the surgical technic employed and (2) on intraductal pressure. The intravenous method will determine which of the two factors is responsible for abnormal findings. In subtotal cholecystectomy, there is frequently formation of a pseudo-gallbladder, which acts as a cushion for the pressure within the bile ducts. Thereby, dilatation of the bile ducts may be prevented. On the other hand, small cystic duct stumps may become dilated when intraductal pressure is increased due to inflammatory changes and spasm of the sphincter of Oddi.

In a series of 53 cases with postcholecystectomy symptoms the cystic duct was visualized in 9. In 3 of these cases, there was saccular dilatation of the stump but no dilatation of bile ducts and no delay of emptying. In this group conservative therapy proved to be successful. In a second group, also consisting of 3 cases, saccular dilatation of the stump was associated with dilatation of the bile ducts and delayed emptying. One patient in this group was treated conservatively and the other 2 surgically. In a third group, consisting of 2 cases, there was a normal stump but dilatation of bile ducts with normal emptying. In 1 patient reoperation was necessary, while the other could be treated conservatively. Normal findings were obtained in a single instance. Postcholecystectomy symptoms were atypical and proved to be due to a hiatus hernia in this case.

Nine roentgenograms with diagrams.

ERNEST KRAFT, M.D.
Northport, L. I., N. Y.

**Percutaneous Transhepatic Cholangiography.** Jorge Remolar, S. Katz, B. Rybak, and O. Pellizari. Gastroenterology **31:** 39–46, July 1956. (Policlinico de Lanus, Buenos Aires, Argentina)

The technic of needle injection of contrast medium directly into the upper biliary tree by puncture through the substance of the liver is described, the purpose being to determine the level of biliary tract blockage when obstructive jaundice has been diagnosed. The procedure was performed in 34 cases, and in 20 good visualization of the intra- and extrahepatic biliary radicles was obtained. A number of representative roentgenograms are reproduced.

Rather striking dilatation of the biliary ducts was observed in several cases; this was more common in benign than in malignant obstructions. Relief of obstruction brought about a remarkable decrease in common duct caliber in 1 instance.

The principal indications for this procedure are: doubtful jaundice in the presence of inconclusive clinical and laboratory tests; postcholecystectomy syndrome with jaundice; differentiation of lithiasis from neoplasm in cases of obstructive jaundice. Intra-abdominal bleeding or choleperitoneum are the principal accidents which might occur. There were no complications in this series.

Twelve roentgenograms; 1 table.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Experimental Evaluation of Operative Cholangiography in Relation to Calculus Size.** J. D. Ashmore, J. J. Kane, Harold S. Pettit, and Henry W. Mayo, Jr. Surgery **40:** 191–196, July 1956. (H. S. P., Department of Radiology, Roper Hospital, Charleston, S. C.)

Cholangiographic studies were carried out in dogs, using groups of radiolucent gallstones, from 2 to 8 mm. in diameter, placed in obstructed and dilated common bile ducts. Various dilutions of Diodrast and Neo-Iopax were employed. A similar study was made in animals with normal ducts. The smaller stones were visualized infrequently in the dilated ducts, even with the more dilute solutions of contrast material.

The authors state that there is no question that operative cholangiography is a valuable adjunct to surgery of the biliary tract and that the results of their study should not be interpreted as a condemnation of the procedure. Their findings, however, do point out its inherent inaccuracy and should lead to its wiser application. It appears that cholangiography should not replace instrumental exploration and irrigation of the common duct. Certainly, negative or normal cholangiograms should be accepted with some misgivings.

Three roentgenograms; 1 table.

**Per-Operative Manometry and Radiology in Biliary Tract Disorders.** Pierre Mallet-Guy and J. Dudfield Rose. Brit. J. Surg. **44:** 55–68, July 1956. (P. M.-G., Lyons, France)

The authors describe a technic of manometric and

radiological control of biliary tract surgery to be carried out at the time of operation, for obtaining precise information on biliary tract function and more exact knowledge of morphological change than is possible from visual and tactile examinations or from instrumental probing of the tract. By a simple device the pressure within the biliary tract is recorded on a manometer during surgery. After this, cholangiographic studies are carried out. If the gallbladder is normal and there is no obvious lesion in the common duct, the manometric pressure readings are taken through the gallbladder. The type of anesthesia used is of prime importance. A nitrous oxide, oxygen, and ether anesthetic has been shown to be without effect on biliary tract function. Drugs which alter the sympathetic-vagal equilibrium (which include those commonly used for premedication) and vasoconstricting preparations should be avoided until completion of the examination.

In a normal state the pressure curve descends regularly and is slightly concave. A pressure of between 8 cm. and 14 cm. of water in the common duct is considered normal. Factors which influence biliary pressure are the secretion of bile by the liver, the tonicity of the sphincters, and the tonicity, elasticity, and contraction of the ducts. If there is loss of the tone of the muscular wall, there will be a low pressure and a rapidly descending curve. If there is an obstruction to the outflow of bile, a high pressure will develop, and if there is a complete obstruction, each stabilized pressure will be higher than the one before. In the normal gallbladder the pressure is usually about 18 cm. of water.

Hypertonia may be functional or organic, due to an obstructive lesion, or a combination of the two. In the hypertonic state there may be visible peristaltic waves in the common duct and reflux often occurs in the hepatic ducts and into the duct of Wirsung. In functional hypertonia infiltration around the terminal vagal fibers with a local anesthetic will abolish the spasm of the sphincter of Oddi and lower the pressure.

A lowered stabilized pressure indicates a state of hypotonia. A hypotonic common duct is usually dilated and evacuates passively through a widely open sphincter. The hepatic ducts are also dilated, often up to two or three times their normal width. Sometimes an extremely narrow duct is seen, with rapid evacuation into the duodenum through a wide open sphincter. Hypotonia may be essential or organic in origin, the latter being associated with other lesions of the biliary tract, such as stones or a pancreatitis.

If there is an obstructive jaundice, the pressure will exceed 30 cm. Above this pressure level there is a reversal of function of the liver cells. Radiologically the duct system is enormously dilated and the common duct is amputated at the level of the head of the pancreas, ending as an irregular cone or hemisphere. In the case of a stone, the duct terminates in a concave line. In carcinoma of the ampulla the duct usually ends in an irregular cone at the level of the papilla; a carcinoma of the pancreas causes obstruction higher up. Tumors of the hepatic duct are also a cause of jaundice and are seen on the cholangiograms as obstructions of the duct.

In the post-cholecystectomy syndrome, the stabilized pressure may be high, normal, or low. A spasm of the sphincter of Oddi is frequently the cause of trouble following cholecystectomy and was found in 20 per cent of the authors' cases. In some instances there is fibrosis of the sphincter. The finding of hypotonia of the sphincter suggests that this may have been present at the time of the first operation. The authors suggest a right splanchnicectomy for this condition. Additional causes of the postcholecystectomy syndrome include stenosis of the common duct due to injury, a co-existent chronic pancreatitis, or tumor. Pancreatitis is diagnosed by careful examination of the pancreas, radiological deformity of the common duct in its pancreatic portion, and frequently by marked reflux along the duct of Wirsung in association with a hypotonia of the sphincter of Oddi.

[The interested reader is directed to the original article for details of technic and graphic illustrations of the normal and abnormal pressure findings.—J. P. F.]

Twenty roentgenograms with manometric tracings; 5 photographs and drawings; 1 table.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

**Splenoportography: A Valuable Adjunct in the Study of Portal Hypertension.** Hector F. Rodriguez, Frank H. Gardner, and Rafael Diaz-Bonnet. Am. J. M. Sc. **232:** 1–7, July 1956. (H. F. R., Ponce District Hospital, Ponce, Puerto Rico)

Splenoportography has the advantage of defining types and degrees of portal hypertension and for this reason is of particular value in schistosomiasis, in which this finding is of frequent occurrence, along with huge splenic enlargement and esophageal varices. Patients with this condition are ideally suited for shunt surgery, and it is in such cases that the authors have found demonstration of the splenic and portal veins useful in clarifying the indications for operation. Postoperatively the procedure permits evaluation of the results of surgery and determination of the patency of the vascular shunt.

Preoperatively, large, dilated splenic and portal veins are demonstrated. The postoperative examination, following portocaval anastomosis, shows a patent shunt with adequate filling of the inferior vena cava. The size of the splenic vein is decreased as compared with the preoperative findings.

The authors report successful splenoportographic studies in more than two dozen patients. They use a 3-inch, 18-gauge needle and Diodrast 70 per cent. The patient is instructed to hold his breath while the needle is thrust upward and medially at 45°. When the spleen is grossly enlarged, the site of puncture is in the axillary line below the costal margin. For a lesser degree of splenic enlargement, the left ninth intercostal space is chosen in the mid-axillary line. Efforts are made to aspirate blood, but failure to do this is not an indication of an unsuccessful splenic puncture. The medium is injected rapidly, 20 to 30 c.c. in three to five seconds. An anteroposterior view is obtained immediately upon completion of injection.

The findings in the various conditions encountered are described as follows:

1. *Normal* (2 cases): Splenic and portal veins with smooth course. Intrahepatic branches well visualized. Collateral vessels not seen.

2. *Splenomegaly without portal hypertension* (4 cases): Splenic vein elongated but of normal caliber. Portal vein somewhat wider. Intrahepatic branches well visualized. Collateral vessels not seen.

3. *Bilharzial cirrhosis* (13 cases): Splenic and portal veins dilated and tortuous. Varices seen in 2 cases,

coronary vein in 1, other collaterals in 2. Intrahepatic branches not seen clearly.

4. *Portal cirrhosis* (6 cases): Splenic and portal veins not as dilated as in 3. Esophageal varices visualized in 2 cases. Intrahepatic branches poorly visualized.

5. *Extrahepatic obstruction; portal vein thrombosis* (1 case): Splenic vein slightly wider than normal; portal vein not visualized. Esophageal varices seen. A large omental vein crossed the abdomen and connected the splenic vein, through collateral branches, to the inferior vena cava.

No serious complications were encountered in this series.

Seven roentgenograms; 1 drawing; 1 table.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

**Splenoportography for the Diagnosis of Portal Hypertension.** José M. Falomir, Manuel Campuzano, and Bernardo Sepúlveda. Arch. Int. Med. **98:** 39–43, July 1956. (J. M. F., Department of Radiology, Universidad Nacional Autónoma de México, México. D. F.)

The authors report their experience with splenoportography for the diagnosis of portal hypertension in 18 patients. The technic originally described by Abeatici and Campi (Acta radiol. **36:** 383, 1951. Abst. in Radiology **59:** 611, 1952) is utilized. The needle is introduced transabdominally into the splenic pulp and is then connected to a membrane electromanometer and a tensiometric tracing is taken by means of an electrical device. This procedure serves to register the portal vein pressure. Following this, 30 c.c. of 70 per cent iodopyracet is injected within a period of four seconds, through a No. 18 needle. A roentgenogram is obtained immediately after injection. The authors have not observed any serious accident in their group of patients. They feel that the contraindications to the procedure are a pronounced tendency to hemorrhage, infectious splenomegaly, and the presence of ascites, which must be aspirated prior to attempting visualization.

The chief usefulness of the method lies in its ability to confirm the existence of portal hypertension, localize the site of obstruction, and demonstrate anomalies of the portal system.

Eight roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

## THE MUSCULOSKELETAL SYSTEM

**Multiple Skeletal Lesions in Young Children Due to Trauma.** Harry Bakwin. J. Pediat. **49:** 7–15, July 1956. (Department of Pediatrics, New York University College of Medicine, New York, N. Y.)

Now that rickets and bone syphilis have become rare, trauma is probably the most common cause of skeletal changes in infants and young children. The clinical manifestations are generally mild and easily overlooked. The history of a traumatic episode is often not obtained because the parents are unaware of it or intentionally suppress details. Often multiple lesions are demonstrated roentgenographically and are confused with some deep-seated bone disease.

Roentgenologically demonstrable changes found in the bones of young children after injury are subperiosteal ossification, avulsion of parts of the provisional zone of calcification, metaphyseal fractures, impacted fractures, gross fractures, and epiphyseal displacements. The most frequent roentgen finding is cortical thickness, the result of periosteal separation and subperiosteal ossification. The periosteum in young children is easily stripped from the bone and is highly vascular. No roentgen evidence of injury is evident immediately, unless there is concomitant fracture, but seven to ten days later a new layer of cortical bone becomes visible. The involved bone is cloaked by a new layer of periosteal bone, generally widest at the end of the affected bone and often extending beyond the epiphyseal line.

Ordinarily the new bone is limited to the subperiosteal space as indicated by the sharp straight outer margin. Sometimes the periosteum is torn and thrown into folds which produce irregular masses of new bone. Subperiosteal ossification along the shafts of the femur and tibia have been observed following trauma of various sorts.

Metaphyseal fractures occur frequently after trauma in infants and young children; they are generally multiple.

Traumatic dislocations of the epiphyseal centers are rare. When the center has been calcified, it can be seen to be out of alignment with the bony shaft.

Generally no treatment of traumatic skeletal lesions in children is necessary, but occasionally the growing cartilage is injured and permanent deformity results.

Twenty-four roentgenograms.

**Aneurysmal Bone Cyst.** Miguel Cruz and Bradley L. Coley. Surg., Gynec. & Obst. **103:** 67–77, July 1956. (Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

Twenty cases of aneurysmal bone cyst are reported. The lesion consists of a benign cystic cavity containing liquid *non-stagnant* blood. It is lined by a mesh of fibrous tissue and is expansile, destroying the cortex of the bone eccentrically and causing a blown-out effect into the adjacent soft tissues.

These cysts are found most frequently in infants, children, and young adults. The majority occur between ten and twenty years. There is a marked predilection for the long bones and the vertebrae, which together account for 75 per cent of the cases, although examples have been reported in nearly every bone. The symptoms are insidious and usually of several months duration, consisting of mild pain, somewhat aggravated by activity, associated with progressive swelling. If the site is near a joint, disability and impairment of function may be present. There is no pulsation on palpation. The cyst usually has attained considerable size by the time medical advice is sought.

Being subperiosteal, the lesion is surrounded by a thin shell of bone, producing a rather specific radiologic appearance. The proximal or distal diaphysis is usually involved. The epiphysis is seldom affected except secondarily in neglected cases. The picture is that of a cystic cavity destroying the cortex, as evidenced by cortical discontinuity. An expansile, denser-than-water mass protrudes eccentrically into the adjacent soft tissues. The rim of this mass is lined by a shell of periosteal new bone measuring a few millimeters in thickness. In the long bones, a variant has been observed in which the lesion is more or less central, causing a fusiform expansion of the bone with destruction of the

cortex on both sides. In the vertebral column, any portion, including the sacrum, may be affected. There may be destruction of the spinous process, the neural arch, or the body of one or several adjacent vertebrae. In this location, as in the flat bones, the appearance may be modified by the local anatomy.

Roentgenologically, an aneurysmal cyst might occasionally be mistaken for juvenile bone cyst, since the location and age group distribution are similar. When the lesion is bulky and there is enough spontaneous attempt at repair, some trabeculation and "soap-bubble" appearance may be present, thus simulating the appearance of a giant-cell tumor. However, in the latter condition the trabeculation is as a rule more uniform, the location is mainly epiphyseal, and these tumors do not occur in children. Also, giant-cell tumors are extremely rare in the vertebrae, one of the favored locations for aneurysmal bone cysts. Non-osteogenic fibroma may at times be a cause of confusion but it lacks the soft-tissue mass and the blown-out effect. Another condition which has been reported as simulating aneurysmal bone cyst is the telangiectatic form of osteogenic sarcoma, and mistakes in diagnosis have resulted in unnecessary amputations.

The treatment is predominantly surgical and is aimed at exposure and eradication of the lesion by curettement supplemented by bone graft as required. When the location is in the spine or in an inaccessible area, roentgen therapy has proved of benefit, and, in some cases, has produced a permanently satisfactory result. Four of the authors' patients were treated by roentgen irradiation alone, 2 by irradiation in combination with surgery, and 1 by radium implantation. Radiation was given in the approximate range of 1,000–2,000 r tumor dose. No instances of spontaneous healing were observed in this series. Since, in untreated cases, the destructive process may go on to involve large areas, surgical intervention is indicated. The main practical consideration is to distinguish this lesion from a telangiectatic type of osteogenic sarcoma and thus avoid unnecessary amputation.

Nine roentgenograms; 4 photomicrographs; 1 photograph; 1 table. MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

**Metaphyseal Fibrous Defects.** James B. Cunningham and Lauren V. Ackerman. J. Bone & Joint Surg. **38-A:** 797–808, July 1956. (Washington University School of Medicine, St. Louis 6, Mo.)

The authors give a good review of metaphyseal fibrous defects (also known as non-osteogenic fibroma of bone) and propose a theory of their development and regression. Their series of cases numbered 15.

Most of the patients are children and young adults and there is no sex preponderance. All of the lesions are found in the metaphyses of the long bones of the extremities, especially the lower extremity. Three of the authors' cases involved upper extremity bone.

On the roentgenogram the defects appear as well demarcated, radiolucent, uniloculated or multiloculated cyst-like areas, eccentrically located. They vary in size from 1 cm. in diameter to 2 × 2 × 5 cm. The cortex is often thinned by the lesion but was usually found intact unless pathological fracture had occurred.

These defects are usually asymptomatic and are discovered incidentally. Treatment is required only if the defect is large or if fracture has occurred. Differential diagnosis is usually not difficult.

Histologically, absence of new bone formation was a constant finding in the authors' series. The lesions apparently arise as a result of some unknown process in which a small area of epiphyseal plate intermittently produces fibrous tissue instead of bone. It is believed that many of these lesions may be extruded from the bone in the process of remodeling of the metaphysis during normal bone growth.

Twelve roentgenograms; 4 photomicrographs; 2 tables. RICHARD A. ELMER, M.D.
Atlanta, Ga.

**Angiosarcoma of Bone: A Review of the Literature and Presentation of a Case.** John H. Carter, Robert Dickerson, and Carl Needy. Ann. Surg. **144:** 107–117, July 1956. (Bellevue Hospital, New York 16, N. Y.)

In a review of the literature the authors found only 8 case reports of angiosarcoma primarily involving the bone, in which they felt that the information given justified the diagnosis. To these are added 8 cases included by Thomas (Surg., Gynec. & Obst. **74:** 777, 1942. Abst. in Radiology **39:** 642, 1942) from a review of the Registry of Bone Sarcoma, which were not reported separately, and a case presented here, bringing the total to 17.

This rare tumor may involve any bone at any age, producing osteolytic areas which are quite painful and tender. Swelling and increased warmth are usual because of an element of arteriovenous fistula in the tumor tissue. Microscopically the lesion is definitely malignant, showing proliferating vascular endothelium forming new blood vessels as the predominant feature.

The films show sharply circumscribed "punched-out areas of rarefaction." These appear, as a rule, to be single, although in the authors' case multiple lesions were present, in the tibia, fibula, and tarsal bones. The diagnosis was made after biopsy. Arteriography demonstrated the numerous abnormal tumor vessels. The patient died within a year of the onset of symptoms.

Details of the previously reported cases are tabulated.

Two roentgenograms; 2 photomicrographs; 2 photographs; 4 tables. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Adenoma of the Parathyroid Gland Associated with Osteitis Fibrosa Cystica.** D. J. Reddy, T. Suryaprakasa Rao, K. Gopalakrishniah Gupta, Sakuntala Devi, M. Muniswamy, and D. Bhaskara Reddy. J. Indian M. A. **27:** 48–50, July 16, 1956. (D. J. R., Guntur Medical College, Guntur, India)

A case of adenoma of the parathyroid gland associated with osteitis fibrosa cystica is reported. Osteolytic and cystic lesions of the long bones, roentgenologically visualized, ruled out a diagnosis of giant-cell tumor suggested by certain histologic features and prompted surgical exploration for probable hyperparathyroidism. Two small nodules over the posterior aspect of the right lobe of the thyroid were removed. The histologic diagnosis was "wasserhelle-cell" adenoma of the parathyroid gland. Following operation, the patient showed remarkable improvement; films of the left ulna and humerus and right femur disclosed disappearance of the cystic spaces and healing by sclerosis. No extension of the lesions into other bones was observed.

The absence of renal lithiasis on repeated roentgen examinations and the soft, firm, yellowish-brown neoplasm made up of "wasserhelle cells" leave little doubt that the case was one of primary hyperplasia. The

rapid and progressive improvement both in the patient's general condition and in the bony lesions as disclosed by follow-up roentgen studies, and the return to normal of the biochemical findings after excision of the adenoma, indicated that all diseased parathyroid tissue had been removed.

Five roentgenograms; 3 photomicrographs.

**Renal Osteodystrophy in Adults.** I. McLean Baird and F. Lees. Arch. Int. Med. **98:** 16–22, July 1956. (Royal Infirmary, Sheffield, England)

Three cases of chronic uremia with bone changes in adults are presented. The outstanding symptom of bone pain and the other clinical features are described.

Two of the cases showed generalized rarefaction of bones and other changes, including wooly appearance of the skull, presumed to represent osteosclerosis with areas of rarefaction; fractures and a pseudofracture; ill-defined trabeculation and a wooly appearance of the spine; early subperiosteal bone resorption in the phalanges; cystic changes, but no large cysts. The remaining case was more difficult to assess, some sclerotic changes in the vertebra and sparsity of trabeculation being all that was noted roentgenologically.

Metastatic calcification and Mönckeberg's sclerosis are often seen in this condition. In 1 of the 3 cases reported here there was some calcification in the pelvic cavity, spermatic cords, and prostate.

Tibial bone biopsy was done in 2 cases and proved the presence of generalized bone disease, although the histologic features shown were not necessarily representative of other parts of the skeleton. Gross local changes were evident radiologically in 1 case in spite of only minimal histologic changes in the biopsy specimen.

Three roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

**Dysplasia Epiphysealis Multiplex. Report of a Case in a Bantu Child.** E. Cope, C. Morris, and S. H. Getz. South African M. J. **30:** 625–628, July 1956. (Coronation Hospital, Johannesburg, Union of South Africa)

A case of dysplasia epiphysialis multiplex in a ten-year-old boy is described, believed to be the first case reported in a Bantu. The clinical and radiographic findings were typical. The radiologic features are (*a*) irregularity in contour and in bony structural pattern of the developing epiphyses; (*b*) multicentric epiphyseal ossification; (*c*) late appearance, slow development, and delayed fusion of the epiphyses; (*d*) varying irregularity of adjacent metaphyses. In the present case, the hip joints, knee joints, ankle joints, feet, shoulder joints, elbow joints, and hands and wrists all were affected; roentgen studies of the spine, skull, and teeth revealed no abnormality. To be included in the differential diagnosis are Perthes' disease, cretinism, dysplasia epiphysialis punctata, osteochondrodystrophy, dyschondroplasia, osteopoikilosis, osteopetrosis, and pituitary gigantism.

Eight roentgenograms.

**The Roentgen Manifestations of Caisson Disease.** Maxwell H. Poppel and William T. Robinson. Am. J. Roentgenol. **76:** 74–80, July 1956. (Bellevue Hospital Center, New York, N. Y.)

The authors reviewed over 190 cases of caisson disease, many with multiple examinations over a twenty-year period. In this condition emboli are produced by the formation of nitrogen gas bubbles in the blood stream and tissues. Under increased atmospheric pressure the blood absorbs an excess of nitrogen from the lungs. With too rapid return to normal air pressure, the lungs are unable to excrete the nitrogen fast enough, and it appears as bubbles in the blood stream, blocking smaller arteries and creating infarcts. The embolic phenomenon, plus pressure and tearing of the tissues, results in infarctions. Tissues with the highest lipoid content absorb the most nitrogen and therefore become the sites of major involvement. Among these is the bone marrow.

Roentgen manifestations of caisson disease are almost pathognomonic due to their sites of predilection and sequence of occurrence in the lower femoral diaphyses, upper tibial diaphyses, humeral head and neck, and femoral head and neck. The diaphyses show areas of aseptic necrosis sometimes accompanied by new bone formation, giving a "map-like" appearance within the medullary cavity. The cortex and periosteum are not involved. The articular lesions consist in subchondral aseptic necrosis with spotty areas of decalcification and new bone formation. The head of the bone may show widening, fragmentation, collapse, and sometimes narrowing or obliteration of the joint space. Healing results in a "snowcap"-like appearance of the articular surface, best seen in the femoral head. The lesions do not cross the joint. The end-result can closely simulate osteoarthritis. The spinal column and the flat bones are usually spared. The disease is progressive and usually takes three to five years to manifest itself.

Nineteen roentgenograms. PAUL MASSIK, M.D.
Quincy, Mass.

**Bone Changes in Kaposi's Sarcoma. An Analysis of 15 Cases Occurring in Bantu Africans.** A. G. M. Davies, J. Fac. Radiologists **8:** 32–40, July 1956. (Mulago Hospital, Kampala, Uganda)

Kaposi's sarcoma, although primarily a skin disease, may produce lesions in other organs of the body. Bone changes are most often seen in the feet, hands, tibiae, or fibulae. Fifteen cases with such bony involvement are reviewed.

Severe uniform demineralization of the involved bone is the commonest radiographic manifestation. Occasionally, there will be poorly defined, irregularly shaped local areas of rarefaction in the ends of the metatarsals and the phalanges of the hands and feet. Similarly situated cyst-like lesions are observed at times, having clear centers, sharp borders, and sometimes sparse trabeculae. Another radiographic variation which may be encountered is cortical erosion, either smooth or ragged, occurring most frequently in the metatarsals and phalanges of the feet. An isolated case of osteolytic destruction of a metatarsal bone was seen.

The rarefaction is attributed to disuse and to hyperemia; the cystic changes are presumed to be due to new primary tumors; and the cortical erosions are thought to result from pressure of adjacent tumor masses.

To be considered in the differential diagnosis are gout, multiple myeloma, multiple chondroma, sarcoidosis, and Madura foot.

Five roentgenograms; 2 photographs; 3 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Bone, Joint and Soft Tissue Changes Following Paraplegia.** Thomas Lodge. Acta radiol. **46:** 435–445, July-August 1956. (Spinal Injuries Centre, Lodge Moor Hospital, Sheffield, England)

The author presents a brief review of the radiologic changes in the pelvis and lower limbs of paraplegic patients. This study is based on the radiographs of 236 paraplegic patients, seen over a ten-year period.

1. *Changes in Bone:* The commonest finding in bone is osteoporosis, which is almost invariably seen in the legs and usually also in the pelvis. A rare complication of the osteoporosis is fracture. Erosion of the bone may take place over pressure points. Occasionally one may see new bone formation over the ischia, having a "whiskered" appearance, as if pulled out from the bone itself. In a minority of cases, this new bone is associated with a nearby decubitus ulcer.

2. *Changes in Joints:* It is worthy of note that in spite of gross ossification *around* a joint there is usually little or no change within the joint itself. Charcot changes are uncommon in paraplegics, probably because the joints are not subjected to weight-bearing stresses.

The sacroiliac joints in 7 of 181 patients for whom roentgenograms were available showed changes consisting of narrowing of the joints with small articular erosions not unlike the appearances in ankylosing spondylitis. In 2 cases the joints were ankylosed.

3. *Changes in Soft Tissues:* The most prominent finding in this series of cases, as in others, was ossification and calcification in the muscular tissues below the level of spinal lesion. These masses of ossification may be single or multiple; they usually appear early, progress rapidly until they obtain a certain size, which varies considerably from case to case, and then remain unchanged. The joints themselves are not involved. Ossification is seen frequently around the hips and knees, and within the thigh.

The various theories to account for ossification in soft tissues are presented.

Seventeen roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

**Technic and Normal Radiographic Anatomy of the Sternum.** Emilio Balzarini and Giuseppe Pompili. Radiol. med. (Milan) **42:** 625–637, July 1956 (In Italian) (Istituto di Radiologia della Università di Milano, Milan, Italy)

Following embryologic considerations, the authors discuss the appearance of the sternum at four stages: (*a*) at three years of age, with a homogeneously dense manubrium with convex outlines and four sternebral ossification centers; (*b*) in the adolescent, when the outline of the manubrium has become concave and the lower sternebrae have fused; (*c*) in the adult, when the angle between the manubrium and body can be demonstrated in the lateral projection and the xiphoid appendix can be seen; in the aged, when the picture either remains unchanged or there is slight osteoporosis, often with fusion of the xiphoid appendix but seldom, if ever, with synostosis between manubrium and body.

The following roentgen procedures for study of the sternum are described, with details of distance, positioning, etc.: (1) simple roentgenography, including oblique and lateral projections; (2) plesiography, with the tube as close as possible to the skin, using the divergent effect of the short focal distance to blur the images of the vertebral bodies and posterior ribs; (3) body-section roentgenography; (4) similar technics involving two or more exposures from a tube moved along a certain path, which, however, are not recommended; (5) contrast methods such as the recently introduced myelosternography, with injection of a contrast medium into the spongiosa.

Seven roentgenograms; 8 drawings.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

**Studies in the Dynamics of the Spine.** Jan Jirout. Acta radiol. **46:** 55–60, July-August 1956. (Neurological Clinic, Charles University, Prague, Czechoslovakia)

On the basis of examination of 1,500 persons with lumbar and cervical radicular pain the author has reached some conclusions which form the subject of this report. The examination is done by lateral films taken in the upright position, with the spine in maximum flexion and extension. This the author calls a "dynamic" study.

In the cervical spine the onset of intervertebral disk degeneration manifests itself by diminution of mobility between two vertebrae in one dynamic segment, usually at the level of the fifth and sixth cervical vertebrae. The lesion appears primarily only in movement in the dynamic examination and therefore is called "dynamic block." This must be distinguished from static block, which may be detected in routine examinations by narrowing of the disk space.

The dynamics of the lumbar spine should be investigated with the patient standing. Disturbances of the mutual connections of the vertebrae are the same as in the cervical spine. Their principal manifestations are diminution of motility and compensatory hypermotility between the two vertebrae.

Sixteen roentgenograms. J. P. CHAMPION, M.D.
Grand Rapids, Mich.

**Congenital Spinal Deformities of Surgical Importance.** Thomas N. Cowie. Acta radiol. **46:** 38–47, July-August 1956. (Radiodiagnostic Department, Western Infirmary, Glasgow, Scotland)

Congenital spinal deformities are essentially manifestations of three primary faults: (1) vertebral fusion, (2) rachischisis (congenital fissure of the vertebral column), and (3) arrested or delayed development. The presence of some congenital malformations strongly suggests that there is an associated malformation of the spinal cord, meninges, or nerve roots.

A radiologist should be suspicious if he finds: (1) fusion involving more than two vertebrae, especially if the laminae are involved; (2) two or more sagittal cleft vertebrae; (3) widening of the spinal canal and, in particular, fusiform widening of a part of a spinal canal; (4) localized spina bifida combined with any of the foregoing faults; (5) extensive spina bifida.

In congenital deformities, it is widening of the vertebral canal which commonly denotes an associated abnormality of the spinal nervous system, and this is considered to be an indication for myelography. If the pedicles retain their normal shape, the lesion is very likely to be a diastematomyelia. If the widening is associated with deformation of the medial aspect of some of the pedicles, it is probable that there is a mass within the spinal canal.

The principal neurosurgical conditions which may be

associated with congenital abnormalities of the spine are meningeal cysts, teratomatous tumors, and diastematomyelia. The meningeal cysts and teratomatous tumors produce erosion of the pedicles, widening of the spinal canal, and occasionally flattening of the vertebral bodies or erosion of their posterior aspects. In diastematomyelia there is a fusiform enlargement of the spinal canal, usually with no deformity, or only minimal deformity, of the pedicles, spina bifida, and multiple vertebral deformities. The presence of a near midline bony spur or spicule is almost pathognomonic. The demonstration by myelography of an opaque column dividing around a translucent area, in the middle of which is a spur of bone, is the most conclusive roentgen evidence of this condition. Occasionally the myelographic picture is similar to that produced by arachnoiditis.

Eight roentgenograms.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

**Right Unilateral Thoracic Spondylosis.** S. Schorr, M. Fränkel, and E. Adler. J. Fac. Radiologists **8:** 59–65, July 1956. (Hadassah University Hospital and Medical School, Jerusalem, Israel)

Calcification of the paravertebral ligaments on the right anterolateral aspect of the thoracic spine, called by the authors right unilateral thoracic spondylosis, has been observed in many patients who have had no symptoms referable to the region. A review of the literature reveals that the condition has long been recognized, but the etiology is unknown. It cannot be definitely related to arthritis, hard physical labor, right handedness, or to senility.

Close study of 78 cases revealed progressive ossification of the paravertebral ligaments, beginning on one or two mid-thoracic interspaces. At first a fine calcific line is seen, which later becomes denser and more extensive, reaching up to the fourth dorsal vertebral level. The process is right-sided, and the end-result is a right unilateral bamboo-spine from T-4 to T-11. Marginal lipping or osteophyte formation may be seen incorporated within the ossified ligaments. The apophyseal joints are spared, the vertebral interspaces are unremarkable, there is no particular demineralization, and the sacroiliac joints are not affected.

The condition apparently is a degenerative process, and in this series there seemed to be a significantly increased incidence in subjects who were overweight. The predilection for the right side is not yet understood.

Six roentgenograms; 2 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Rheumatoid Spondylitis and Aortic Insufficiency.** Donald P. Schilder, W. Proctor Harvey, and Charles A. Hufnagel. New England J. Med. **255:** 11–17, July 5, 1956. (W. P. H., Georgetown University School of Medicine, Washington, D. C.)

In the course of examination of 100 persons with aortic insufficiency for evaluation in reference to possible surgery, 5 were found to have typical rheumatoid spondylitis with the characteristic calcification of the vertebral longitudinal ligaments, osteoporosis, narrowing and irregularity of the lateral intervertebral articulations, and involvement of the sacroiliac joints. Clinical, electrocardiographic, and radiologic findings confirmed the diagnosis of aortic insufficiency.

Unlike the valvular heart disease accompanying rheumatoid spondylitis previously reported, the heart disease in these cases was not benign; it was preceded by rheumatic fever and by peripheral rheumatoid arthritis in only one instance each. In none of the 5 cases, which are reported in detail, was there a history of syphilis. Congenital and traumatic possibilities for the valvulitis were likewise excluded. Postmortem examination in 2 of the 3 patients who died revealed aortic valves that were insufficient, thickened, and shortened, with fibrosis at the base without commissural irregularities and without Aschoff bodies. Both cases showed normal mitral valves with involvement of all the layers of the aortic root.

From the evidence it would seem that rheumatoid spondylitis, which may be called a collagenous disease, closely related to rheumatic fever and rheumatoid arthritis, may cause heart disease with a predilection for the aortic valve, where it produces both an endocarditis and a valvulitis. The valvulitis and heart disease develop some years following the manifestations of the rheumatoid spondylitis.

Four roentgenograms; 2 figures; 1 table.

SAUL SCHEFF, M.D.
Boston, Mass.

**Concerning the Etiology of Osseous Bridges Between Lumbar Transverse Processes.** E. de Cuveland. Fortschr. a. d. Geb. d. Röntgenstrahlen **85:** 93–95, July 1956. (In German) (DRK-Krankenanstalten Wursterheide, Kreis Wesermünde, Germany)

The author reports the case of a thirty-two-year-old carpenter who had suffered from occasional indefinite low back pain. Physical examination was entirely negative. The supine roentgenogram revealed a fairly broad osseous bridge arising from the lower border of the left transverse process of L-2, extending in a downward direction and articulating with the transverse process of L-3. On the lateral view this osseous bridge had the appearance of a lumbar rib. In addition, a typical lumbar rib was present at L-4, articulating with the left transverse process.

These findings have previously been called "sacralization" of lumbar vertebrae. Medicolegally, knowledge of the anomaly will prevent an erroneous diagnosis of post-traumatic changes and will guard against unnecessary operations.

The author believes that the bone formations represent developmental abnormalities which can be considered rudimentary lumbar ribs similar to the so-called styloid processes of the lumbar vertebrae.

Two roentgenograms.

ERNEST KRAFT, M.D.
Northport, L. I., N. Y.

**Osteo-Arthritic Occlusion of the Intervertebral Foramina of the Cervical Spine.** Geoffrey Doel. J. Fac. Radiologists **8:** 66–72, July 1956. (Enfield Hospital Group, London, England)

The author emphasizes the importance of degenerative lipping of the so-called uncovertebral articulations as a cause of cervical nerve root pressure and brachialgia. [These small synovial joints, so frequently ignored in anatomical texts, are situated between the lower cervical vertebral bodies. They are known also as Luschka joints. See Boreadis and Gershon-Cohen: Radiology **66:** 181, 1956.—Ed.]

At the C5-C6 level the nerve root canals are smaller than those above and below, and any narrowing of the

foramina may cause root pressure effects. The uncovertebral joints are small and so placed that they enter into all relative movements of adjacent vertebrae. As their articular surfaces become lipped, they irritate or actually compress the brachial plexus nerve roots.

Seventy-three cases of brachialgia are reviewed, in 40 of which there were hypertrophic uncovertebral changes of significant degree. These can best be demonstrated by oblique radiographs.

Occasionally cases are encountered in which there is no x-ray evidence of nerve root foramina narrowing. In these it is suggested that chemical changes associated with early osteo-arthritis may be causing root irritation.

Six figures, including 2 roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Clinical Significance of Discography.** L. Walk. Acta radiol. **46:** 36–37, July-August 1956. (Roentgen Department, Centrallasarettet, Eskilstuna, Sweden)

The clinical significance of discography was analyzed in a series of 200 cases. These are divided into four groups: normal, disk rupture with only slight deformity of the nucleus pulposus, degenerated disk, and degenerated disk with rupture.

Lumbar intervertebral disk lesions give rise to two neurologic syndromes: (1) compression of the nerve by the disk and (2) irritation of the nerve by perineural spread of the contents of the nucleus pulposus. Compression is characterized by numbness, but pain on coughing is absent; a strong positive Lasègue sign may be found in cases of varying duration, and reflex, sensibility, and extensor changes are frequent. Irritation is characterized by pain on coughing, but numbness is found uncommonly; a strong positive Lasègue sign is frequent in acute cases, but rapidly diminishes, and after three to four months occurs only exceptionally; reflex, sensibility, and extensor changes are less frequent than in compression.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

**Asymptomatic Intervertebral Disc Protrusions.** Donald L. McRae. Acta radiol. **46:** 9–27, July-August 1956. (Montreal Neurological Institute, Montreal, Canada)

Radiologic evidence of disk protrusion may be of several types. The small round or square defect in the upper or lower part of a vertebral body outlined by compact bone on the roentgenogram is accepted as a Schmorl's node, an old upward or downward protrusion of the nucleus pulposus. The bony spur projecting from the edge of a vertebral body indicates the position of an underlying intervertebral disk. If the spur projects at an angle to the normal annulus fibrosus, there is invariably a protrusion of disk tissue in the corresponding direction. In 33 spines that were radiographed and sectioned, the direction of the bony spur always showed the position of the underlying disk. Visualization of a calcified nucleus pulposus in an abnormal position between adjacent vertebral bodies is suggestive of protrusion of that disk in the direction of the abnormal position. If the calcified nucleus pulposus is no longer between the vertebral bodies, the diagnosis of disk protrusion can be definitely made.

The spines of 18 subjects, thirty years of age and over, were sectioned and studied. In 12 of these there were disk protrusions. Anterior cervical disk protrusions were present in 39 per cent; these were accompanied by anterior osteophytes in each case. Lateral cervical disk protrusions were present in 28 per cent and lateral osteophytes in 34 per cent. Posterior cervical disk protrusions were found in 34 per cent and posterior osteophytes in an equal number.

Two hundred and forty consecutive radiographic examinations of the cervical spine in patients of thirty years or over were divided into three groups. The first group consisted of patients with neck-shoulder-arm syndrome thought to be due to posterolateral cervical disk protrusion. The second group was made up of patients with disease of the cervical spinal cord in whom cervical spondylosis or mid-line posterior cervical disk protrusion was thought to be the probable cause. The third group consisted of patients without signs or symptoms of cervical spondylosis or cervical disk disease. Approximately equal numbers of normal-appearing cervical roentgenograms were obtained in the asymptomatic and symptomatic groups of the same age.

One hundred and fifty-nine consecutive cervical myelograms in patients thirty years of age or over were analyzed after dividing them into symptomatic and asymptomatic groups. There was no significant difference in the number of abnormal myelograms in the two groups. The analysis suggests that any patient over thirty years of age, no matter what symptoms or signs he presents, is apt to have a posterior cervical disk protrusion. In the symptomatic cases, the side to which a posterior protruded disk projected correlated well with the side to which the symptoms were referred. In patients with right-sided as well as left-sided posterolateral protrusions of one cervical disk, the largest protrusion was always on the side of the symptoms.

One hundred and sixty-one consecutive lumbosacral roentgenograms of patients thirty years or over were similarly classified into asymptomatic and symptomatic groups. Posterior bony spurs signifying posterior disk protrusions at the last two disk levels were significantly more common in patients with low back or root pain than in asymptomatic patients. Thin disks were also significantly more common in patients with low back or root pain. Nuclear expansions producing deep concavities on the articular surfaces of L-4, L-5 and S-1 were definitely more common in the symptomatic group. Anterior and lateral bony spurs, signifying anterior and lateral disk protrusions, were only slightly more common in the symptomatic than in the asymptomatic patients. However, it is emphasized that exactly the same radiological changes may be seen in two patients of the same age, one with no present or past history of low back pain or sciatica and the other with a history of recurring lumbago and sciatica.

One hundred and sixty-nine consecutive lumbar myelograms on symptomatic and asymptomatic patients, age thirty or over, were analyzed. A significantly greater number of abnormal lumbar myelograms was found in the symptomatic patients of thirty to fifty-nine years than in the asymptomatic group. In the patients sixty or over, all of the myelograms were considered to show medium-sized or large posterior or posterolateral disk protrusion. The total number was two and a half times as great in the symptomatic as in the asymptomatic group.

Twenty-nine illustrations.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

**Myelographically Demonstrated Lesions of the Cervical Intervertebral Discs, Co-Existing with Tumors and Other Causes of Myelopathy.** Fritz Cramer and Frank Hudson. Acta radiol. **46:** 31–35, July-August 1956. (Neurological Institute, New York 32, N. Y.)

In recent years the importance of ruptures and degenerative-proliferative disorders of the intervertebral disks in the genesis of painful and paralytic affections of the nerve roots and spinal cord has become increasingly clear. The increasing use of myelography as a diagnostic tool has permitted the exact localization and the earlier diagnosis of intervertebral disk lesions and spinal cord tumors. The prevalence of disorders of the disks and their neurologic manifestations has tended to overshadow spinal cord tumors, which formerly took diagnostic precedence. Four cases are presented in which the recognition of discogenetic lesions led to failure in the diagnosis of the tumors of the cord which were responsible for the neurological manifestations. Three of the tumors were intramedullary and one extramedullary.

The authors emphasize the fact that with intramedullary tumors the spinal cord is always increased in width, while with ventral compression by disk herniation it is within normal limits. In cases with a disk lesion or extramedullary tumor, the proximal nerve roots can be followed to their normal insertions in the lateral sulci, with local deformities caused by herniation or tumor, while in cases with intramedullary tumor, the roots tend to be obliterated in the tumor region.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

**Suboccipital Gas Myelography in the Diagnosis of Herniated Disc in the Cervical Segment.** H. H. Jacobsen. Acta radiol. **46:** 28–30, July-August 1956. (Department of Radiology, Bispebjerg Hospital, Copenhagen, Denmark)

Suboccipital gas myelography combined with tomography demonstrates the spinal subarachnoid space from the occipital foramen to the terminal cistern. Gas is less irritating than aqueous opaque media, such as Skiodan, which are useful only in the lumbar region. Gas also has the advantage of being completely absorbed, unlike iodized oils. The author examines the lumbar subarachnoid space with Skiodan, the lower thoracic segment and the high lumbar space with gas myelography combined with tomography, and the cervical space and upper thoracic segment with suboccipital gas myelography. He states that Pantopaque should be used only in elderly persons and cardiac patients, or where abnormal curvatures of the spine prevent tomography.

Four cases are presented which illustrate the use of suboccipital gas myelography in the diagnosis of herniated cervical intervertebral disks.

One roentgenogram.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

**Infectious Spondylitis Following Damage to the Anterior Longitudinal Ligament (Contribution to the Spondylitis Following Paravertebral Anesthesia).** W. Porstmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **85:** 66–75, July 1956. (In German) (Universitäts-Röntgeninstitut der Charité, Berlin, Germany)

Infectious spondylitis is a term which connotes nonspecific hematogenous infections of the spine. True osteomyelitis represents a variety, being a more virulent infection with abscess formations. In addition to the hematogenous type, a new form following paravertebral anesthesia with damage to the anterior longitudinal ligament has been recognized in recent years. The roentgen findings are similar to those of the hematogenous infection, but the following differences have been noted:

1. The disease usually extends over larger areas (up to fourteen vertebrae), while the hematogenous form is confined to two or three vertebrae at the most.
2. The disks and adjacent portions of vertebral bodies are always involved.
3. Large areas of bone destruction have not been observed, but the disk tissue can be entirely absorbed.
4. No paravertebral abscess formations have been noted.
5. Reparative processes such as osseous sclerosis and smoothing of bone erosions begin early, in contrast to their marked delay in tuberculous spondylitis.
6. Healing takes place at an average of nine months, either with fibrous ankylosis of the vertebral bodies (block vertebrae) or with osseous bridging when disks are not entirely destroyed.
7. Roentgen diagnosis is possible only after two months, an early sign being the unsharp bony texture of vertebral bodies close to the disks. The latter are always narrowed subsequently.
8. Symptoms and signs, as fever, increased sedimentation rate, leukocytosis, and meteorism can usually be traced back to the time of a paravertebral anesthesia. Often, localized tenderness occurs a few days and sometimes even a few hours following the injection.

Three cases are reported and illustrated.

Twelve roentgenograms. ERNEST KRAFT, M.D.
Northport, L. I., N. Y.

**Coxa Plana in Dizygotic Male Twins.** Paul S. Derian. J. Bone & Joint Surg. **38-A:** 901–907, July 1956. (Alfred I. du Pont Institute, Wilmington, Del.)

The author reports the occurrence of bilateral coxa plana in twins, in one of whom there were no symptoms. This he believes substantiates the fact of the insidious onset of this condition and emphasizes the importance of obtaining radiographs even in the presence of minor hip complaints in the young. This is especially true if there is a family history of coxa plana.

It is of interest that both twins showed some retardation of bone growth, their bone age being considerably less than their chronological age. The coexistence of coxa plana and retarded bone growth is considered coincidental, inasmuch as no remarkable relationship between coxa plana and abnormal development has been reported in large series of cases.

Five roentgenograms. RICHARD A. ELMER, M.D.
Atlanta, Ga.

**Lesions of the Bones of the Leg in the Course of Varicose Ulcers.** A. Poirault. J. de radiol. et d'électrol. **37:** 531–536, July-August 1956. (In French) (Blois, France)

Indolent varicose ulcers of the legs give rise to changes in the tibia and fibula. There is at first a localized thickening of the periosteum, later involving a much larger area and affecting the cortex of the bone. This gives rise to an osteoperiostitis, which in some cases may simulate osteomyelitis. The bone may become more radiolucent, simulating disuse atrophy.

The knee, ankle, and upper tibiofibular articulation are seldom involved. The lower tibiofibular articulation may be involved to variable degrees, even to the extent of eventual fusion.

Seventeen roentgenograms.

CHARLES M. NICE, JR., M.D., PH.D.
University of Minnesota

**Fabella Distalis: A New Sesamoid Bone.** Josef Slanina. Radiol. clin. **25:** 274–277, July 1956. (In English) (Budějovická 30, Prague 14, Czechoslovakia)

The *fabella distalis* is a sesamoid bone within the popliteal muscle, found just dorsal and medial to the head of the fibula. The author reports here the first case with a correct diagnosis in the radiologic literature and the fourth case in literature available to him. This bone measured 6 × 8 mm. It presented a longitudinal fissure, a fabella bipartita. Its structure and localization and bilateral symmetry exclude calcium deposits, chondromatosis, bursitis calcarea, etc.

Six roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Osteochondritis Dissecans of the Ankle Joint. Report of a Case Simulating a Fracture of the Talus.** Bruce M. Cameron. J. Bone & Joint Surg. **38-A:** 857–861, July 1956. (U.S. Naval Hospital, Yokosuka, Japan)

The author reports the case of a young man who sustained an injury to the ankle. A diagnosis of fracture was made and a weight-bearing plaster boot was applied. Roentgenograms were made at regular intervals. These demonstrated changes progressing from an almost insignificant sclerotic line in the trabeculae of the talus to the classical picture of osteochondritis with loose-body formation. Following the development of the loose body, union began to occur. At this point, the cast was removed for nineteen days, and the roentgenograms promptly showed evidence of regression to non-union with loose-body formation. The cast was then reapplied, and union subsequently occurred.

This case lends support to the theory of trauma alone as the etiology of osteochondritis dissecans and suggests that, in the ankle, osteochondritis dissecans with loose-body formation represents either a fracture that is progressing toward non-union or a fracture in which non-union is already established. It indicates that the changes are reversible with immobilization if this is started before true non-union is present.

Fifteen roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

## THE SPINAL CORD

**Roentgen Study of Spinal Cord Tumors in Children.** J. Lefèbvre, M. R. Klein, J. Lepintre, and C. Fauré. Acta radiol. **46:** 48–54, July-August 1956. (In French) (Service de Radiologie et Clinique Chirurgicale Infantile de L'Hôpital des Enfants-Malades, Paris, France)

Eighteen spinal cord tumors were observed in children under seventeen years of age: 6 sympathicoblastomas, 2 neuroepitheliomas, 2 astrocytomas, 1 glioma, 1 medulloblastoma, 1 meningoendothelioma, 2 sarcomas, 1 lipoma, 1 neurinoma, and 1 chondroma.

The radiological examination included standard and oblique views of the entire spine, as well as tomography when required. The simple radiologic study gave more or less complete information as to the nature of the underlying process in 16 cases. The radiological abnormalities were those of static deformities, enlargement of the spinal canal, abnormal form or structure of the vertebrae, and enlargement of the intervertebral foramina in the dumb-bell type of tumor.

The high incidence of significant findings on the simple radiographic examination is peculiar to this age group as compared with adults.

Seven roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

## THE GENITOURINARY SYSTEM

**Acute Renal Failure Following Translumbar Aortography.** Owen C. Berg. South. M. J. **49:** 494–495, May 1956. (500 Broad St., Wichita Falls, Texas)

A case of acute renal failure following translumbar aortography is reported to emphasize again the possibility of the occurrence of this complication with any of the contrast agents currently being employed. The circumstances leading to renal failure in the present case are not readily apparent, but the use of a large amount of concentrated medium (45 c.c. of 70 per cent Urokon Sodium) may have been a factor. It is suggested that hypotension with possible renal ischemia may have been the precipitating mechanism.

For seven days following aortography the patient had a severe oliguria, excreting less than 200 c.c. of urine daily. She was treated conservatively, with restriction of fluid and electrolyte intake and the administration of sugar and other carbohydrates by mouth. Although the blood urea nitrogen on the seventh day was reported as 188 mg. per cent, the total base, chlorides, and bicarbonate remained within almost normal limits. On the eighth day the patient excreted 900 c.c of urine, and the amount of urine excreted increased each day thereafter until the fourteenth day, when she excreted over 5,000 c.c. of a very dilute urine. This tremendous diuresis continued for almost four months. Renal function studies at the end of this period revealed no evidence of remaining renal damage, and the patient was able to excrete a concentrated urine.

**Polycystic Disease of the Kidney in Infants. Nephrograms Following Intravenous Urography.** C. L. Hinkel and L. C. Santini. Am. J. Roentgenol. **76:** 153–160, July 1956. (L. C. S., George F. Geisinger Memorial Hospital, Danville, Penna.)

Polycystic disease may be divided into adult and infantile types. In contrast to the finding of large cysts in the classical adult disease, the infantile kidney contains innumerable tiny cysts and shows no calyceal or pelvic distortion.

When urographic studies are performed, the appearance of a nephrogram suggests intrarenal obstruction. Apparently the contrast medium accumulates within the dilated tubules and within the substance of the epithelial cells lining them. This permits evaluation of the overall kidney size and shape, and typically discloses kidney enlargement. The presence of mottling and linear radiolucencies in the nephrographic density indicates cysts in the parenchyma.

In the differential diagnosis, one must consider hydronephrosis, which can be established by pyelograms, and bilateral renal tumors, which are extremely rare in newborn infants.

One case is reported in detail. The child died, and the autopsy report is included.

Four roentgenograms; 2 photographs; 1 photomicrograph.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Experiences with Triopac. A New Tri-Iodine-Containing Contrast Material, for Intravenous Urography.** J. Wellauer and M. Del Buono. Schweiz. med. Wchnschr. **86:** 811–814, July 14, 1956. (In German) (Rontgendiagnostischen Zentralinstitut der Universität Zürich, Zürich, Switzerland)

The authors report their experience with a new contrast material, Triopac, which is an aqueous solution of the sodium salt of 3-acetylamino-2,4,6-tri-iodobenzoic acid, with a molecular weight of 614.9. It shows a very low toxicity, the LD 50 for rats being 11.6 gm./kg. on intravenous injection. This is comparable to Urokon (LD 50, 11.6 gm./kg.).

Urografin (Renografin) has a slightly lower toxicity, but larger doses are needed. Triopac was used in 400 cases, 329 times in a 50 per cent solution, 36 times in a 30 per cent solution, and in 35 cases (very heavy patients) in a 70 per cent solution. Minimal reactions were noted in a few cases (pulse changes and feelings of warmth, as well as flushing of the face). Only 4 patients experienced nausea. No serious reactions occurred. If the contrast material was slightly heated, pain at the injection site was not present. The results were good. An excellent pyelogram was obtained in 30 per cent of the cases; 60 per cent showed a good pyelogram and 7 per cent a poor pyelogram. In 3 per cent there was no excretion of the medium, because of diminished kidney function.

The authors point out that the salt concentration of the contrast preparation often has very little to do with the actual iodine content per cubic centimeter. Urografin 30 per cent contains only 146 mg. of iodine per c.c., while Triopac contains 400 mg./c.c. and Urokon 70 per cent contains 460 mg./c.c. No difference between an organic salt of Triopac and the inorganic sodium salt could be observed.

Two roentgenograms; 1 table.

JULIUS HEYDEMANN, M.D.
Chicago, Ill.

**Danger of Aortography in the Localization of Pheochromocytoma.** Nathan J. Saltz, Edmund M. Luttwak, Armin Schwartz, and Gil M. Goldberg. Ann. Surg. **144:** 118–123, July 1956. (Rothschild-Hadassah University Hospital, Jerusalem, Israel)

A case of pheochromocytoma is reported in which death occurred as a direct result of aortography, done to localize the tumor after pyelography and air insufflation failed to indicate definitely on which side the growth lay. The clinical history and various laboratory tests were typical for the lesion but it was necessary to determine which side to explore.

Aortography was done without incident, clearly outlining the tumor. One hour later the patient went into a hypertensive crisis, followed by profound peripheral collapse eleven hours after the aortic injection. She expired twenty-four hours after examination, death being attributed to a hypertensive crisis resulting from the pouring out of large amounts of adrenalin with the eventual development of an "adrenalin shock." At autopsy hemorrhage was found retroperitoneally around and within the right adrenal and the tumor, not, however, related to the aortic puncture. It is postulated by the authors that the bleeding was caused by a chemotoxic effect of the Diodrast on the tumor vessels and that the pressure resulting from the escaped blood forced large amounts of vasoconstricting hormone from the pheochromocytoma into the general circulation to produce the fatal reaction. They conclude that aortography should not be performed when a pheochromocytoma is known or suspected to be present.

One roentgenogram; 2 photographs; 2 photomicrographs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

## RADIOTHERAPY

**Results of Radiotherapy of Brain Tumors 1945-1954.** Hellmut Schwenkenbecher. Strahlentherapie **100:** 399–407, July 1956. (In German) (Strahlen-Institut der Philipps-Universität Marburg/Lahn, Marburg/Lahn, Germany)

One hundred forty-five patients were referred to the Radiotherapy Department of the Philipps University, Marburg/Lahn, for treatment of brain tumor between 1945 and 1954. The diagnosis was disproved in 10. Of the remaining 135 patients, 127 could be followed adequately. On Dec. 31, 1955, 33 were still alive. Of these, 13 felt well and were able to work, 14 felt well but were unable to work, and 11 were in poor condition. The average survival time was 26.1 months. In 65 cases a histologic diagnosis was obtained. Tables are included, presenting details of all treated tumors—their histology, mode of treatment, and their response to therapy. Eleven different histologic diagnoses were made. The longest survival time was observed in ependymomas and meningiomas, the shortest in glioblastomas and spongioblastomas. The tumor dose varied from 3,000 to 9,000 r. The author gained the impression that the highest doses give the best results. Twenty-one patients received pendulum treatment. Again the impression was gained that it produced better results than the stationary beam method.

Only 56 of the patients underwent surgery (17 for total resection, 23 for subtotal resection, 12 for trepanation, and 4 for Torkildsen drainage).

Two graphs; 2 tables.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

**Radiotherapy of Cancer of the Lung. Results in a Selected Group of Cases.** Joseph Smart and Gwen Hilton. Lancet **1:** 880–881, June 9, 1956. (J. S., London Chest Hospital, London, England)

The authors have treated 33 cases of lung cancer by radiotherapy, the first eight years ago. Each patient was selected for irradiation on the following basis: his general condition was good; the lesion was localized and situated in such a position that surgery could be

undertaken; there was no evidence of mediastinal lymph node involvement, clinically, radiologically, or on bronchoscopy. In each case definite histologic proof was secured by bronchoscopy and histologic section, or by a positive sputum for neoplastic cells.

Careful preparation of the patient before irradiation was considered essential, and he was kept under close medical supervision throughout the course of treatment.

Great care was taken in localizing the tumor and assessing the volume to be irradiated, since it is felt that one of the chief causes of failure of radiotherapy in bronchial cancer is insufficient dosage to the whole of the cancerous tissue. The size and disposition of the treatment fields depended on the size of the tumor-bearing area. The multiple small-field technic was used only if the growth was a squamous carcinoma. For undifferentiated or oat-cell tumors, the fields were increased to cover the whole of the mediastinum. The inclusion of so large an area was considered necessary because of the almost certain involvement of many of the mediastinal nodes.

A dose of 5,000 to 5,500 r was delivered to squamous-cell carcinomas, but only 4,000 to 4,500 r to undifferentiated tumors. The length of the treatment and the amount of radiation to be delivered each day were not prearranged. Great importance was attached to varying the daily dosage according to the patient's condition. The whole course of treatment usually lasted seven to eight weeks.

A follow-up of five years or more was possible in 12 patients. Four were still alive and well at the time of the report: 3 of these had squamous-cell carcinoma and 1 an anaplastic carcinoma. One patient survived three years, 2 survived two years, and 5 died within the first two years. This gives a five-year survival rate, in this very limited number of cases, of 33 per cent, which is similar to that obtained with surgery. While these figures are of no statistical value, the authors believe that the results of radiotherapy may eventually bear comparison with those of surgery. With improved apparatus and greater skill, the results with irradiation may reasonably be expected to improve.

Three factors which may influence the results of treatment are mentioned: (1) There is no immediate mortality after radiotherapy, whereas in one series quoted the operative mortality was 10 per cent. (2) Clinical evidence of cerebral metastases seems to be more common after surgery than after radiotherapy. (3) Some cases thought to be operable have been found at surgery to be inoperable. This error may well have occurred in the authors' selection of cases; hence, some cases may have been included that were more advanced than was evident.

Two tables.

**Grid Therapy of Bronchial Carcinoma.** Ernst Kahr. Strahlentherapie **100:** 378–384, July 1956. (In German) (Zentral-Röntgen- und Radium-Institut des Landeskrankenhauses Graz, Graz, Germany)

Fifty-six patients with inoperable bronchogenic carcinoma were treated through a round-holed grid with 30 per cent of the area open (180 kv, 0.5 mm. copper filter), receiving up to 12,000 to 15,000 r (in air?) per port, with a tumor dose of 3,480 r in three to four weeks. Twenty-nine cases were verified histologically before treatment and 46 after treatment (at autopsy); 19 remained unproved at the time of the report.

Only 10 patients were still alive, six, eleven, and thirteen months after the institution of treatment. For those who died, the maximum survival time was twelve months. The author concludes that this type of treatment offers no improvement over conventional deep therapy. Temporary palliation was observed.

Six illustrations; 4 tables.

GERHART S. SCHWARZ, M.D.
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**Bronchial Carcinoma. Effect of Radiotherapy on Survival.** J. R. Bignall. Lancet **1:** 876–879, June 9, 1956. (Institute of Cancer Research, Royal Marsden Hospital, London, England)

During the years 1951–1953, 996 patients with bronchial carcinoma were seen at the Brompton and Royal Marsden Hospitals, London: 221 of these were treated surgically and 321 by radiotherapy; 454 received no treatment likely to prolong life materially. The author has made a study of the survival of 248 of the untreated patients and 207 of those treated by radiotherapy. The groups for comparison were taken from those patients without evidence of extrathoracic metastases when the decision concerning treatment was made, who lived for at least a month after first attending the hospital, and in whom the time of the appearance of symptoms was known. The 207 patients in the radiotherapy group were divided into two subgroups: 114 patients who received an estimated tumor dose of 1,000–3,900 r, and 93 who received a dose of 4,000 r or more.

The greatest difference between treated and untreated patients in the duration of life from first attendance at the hospital was found in those without mediastinal metastases treated with 4,000 r or more: 35 per cent lived a year and 15 per cent two years, compared with 24 per cent and 6 per cent of the untreated. In the patients with mediastinal metastases the difference was less; the pattern of survival of those treated with 1,000 to 3,900 r was almost identical with that of the corresponding untreated group.

There seems to be suggestive but by no means conclusive evidence that radiotherapy prolonged the life of some patients in the series; but, even if life were prolonged, the author believes it highly unlikely that the larger doses of irradiation given to the most favorable patients—those without manifest mediastinal metastases—caused an increase of as much as 10 per cent in the proportion surviving a year after first attending the hospital or 5 per cent in those living for two years.

Two tables.

**Radiotherapy in Renal New Growths.** E. W. Riches. J. Fac. Radiologists **8:** 19–27, July 1956. (Middlesex Hospital, London, England)

Although the sensitivity of adenocarcinoma of the renal parenchyma to irradiation varies from case to case, statistics appear to indicate the advisability of radiotherapy after surgical removal has been performed.

Having reviewed a large number of cases, the author confirms the above statement, and advocates similar management for certain cancers of the renal pelvis. The finding at operation of local extension of tumor outside the kidney is regarded as an added indication for irradiation. Even when there is gross involvement of the renal vein, it is felt that such treatment delays recurrence. A dose of 5,000 to 6,000 r is recommended.

When the tumor is very large or the kidney is fixed,

it is believed that there is more likely to be a high degree of malignancy and therefore greater responsiveness to x-ray therapy. Accordingly, a preoperative dose of 3,000 r in three weeks is suggested, to be followed by surgery within ten days.

Renal pelvic tumors should receive postoperative irradiation if there has been any spill of urine or tumor during surgery, or if the ureter has not been removed. They do not usually respond well to irradiation.

Wilms' tumors may occasionally be irradiated before operation to shrink large, fixed masses, but postoperative treatment is now usually favored. Results, however, are generally poor.

X-ray treatment is often worth trying for recurrent or metastatic lesions, but is not used by the author if metastases have appeared in the lungs.

Eleven figures; 3 tables.

DON E. MATTHIESEN, M.D.
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**Intracavitary Irradiation of Carcinoma of the Bladder.** N. E. Berry and R. C. Burr. Canad. M. A. J. **75:** 93–97, July 15, 1956 (Queen's University and Ontario Cancer Foundation, Kingston Clinic, Kingston, Ont.)

The pathological types of bladder tumor are reviewed, with the general indications for surgery and irradiation for each. The results obtained with various combinations of radiotherapy and surgery are cited from the earlier literature.

The authors generally select radiotherapy for cases in which there have been numerous recurrences following surgery, cases with so many lesions that complete resection is impractical, and for many deeply infiltrating tumors. They use a 25-mc pellet of radioactive cobalt as an intracavitary radiation source. The cobalt pellet is placed in the tube of a large Foley-type retention catheter. The bulb of the catheter is filled with a solution of methylene blue and sodium iodide to allow detection of fluid escape and to permit filming for localization of the catheter and the radioactive source in the bladder. The catheter is introduced into the bladder through the urethra without any surgical procedure. A total dose of about 8,000 r to the surface of the bladder mucosa is given in two equal treatments separated by a four-day rest period. Opening of the bladder and other surgical procedures are avoided if at all possible. Immediate results have been encouraging, and immediate complications limited to dysuria and urgency lasting about three weeks. For an extensive infiltrating carcinoma the above treatment may be supplanted by rotation therapy, utilizing a 2-MEV roentgen beam.

Two roentgenograms. JAMES W. BARBER, M.D.
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**Perifolliculitis Capitis Abscedens et Suffodiens: Its Successful Treatment with X-Ray Epilation.** Francis H. McMullan and Israel Zeligman. Arch. Dermat. **73:** 256–263, March 1956. (F. H. M., 1001 W. Franklin St., Richmond, Va.)

Perifolliculitis capitis abscedens et suffodiens is a chronic inflammatory disease of the scalp characterized by the presence of large and small nodules which suppurate and intercommunicate by sinus formation. It occurs most frequently on the vertex and occiput. It is predominantly a disease of males and in the United States frequently of Negroes. Four patients who had received adequate antimicrobial therapy without permanent benefit were successfully treated by temporary x-ray epilation (365 r, 80 kv, 10 ma, 25 cm. T.S.D.). The inflammatory process did not resolve immediately after irradiation or immediately after epilation was complete. There was, however, a slow but steady regression in all 4 patients both of objective signs (fluctuation, drainage, nodules, communicating ridges, and tenderness) and of subjective symptoms (pain and burning). Two patients had a light recurrence of minimal folliculitis in the treated area, but this responded to simple topical therapy with antimicrobial ointments. Hair has regrown in all cases except where there was hypertrophic or atrophic scarring prior to x-ray epilation.

Four photographs; 1 table.

**Afterloading—A Contribution to the Protection Problem.** Keith S. Mowatt and Keith A. Stevens. J. Fac. Radiologists **8:** 28–31, July 1956. (K. S. M., Queensland Radium Institute, Brisbane, Australia)

The authors describe an implantation technic for radium, radon, or radioactive cobalt sources, which provides considerable protection for the operator from exposure.

Empty, hollow needles are implanted in whatever geometric pattern is desired. Thus, large or complex implants can be performed without haste. After the implant has been completed, the radioactive sources are inserted in the needles.

The needles are designed so that they can be introduced with the assistance of a plastic stabilizer or guide if desired. The inserts are easily locked into place. The authors use radon seeds as sources, and recommend the use of plastic stabilizers or guides.

One case is described in which the implantation required twenty-five minutes, and the "afterloading" required ninety seconds.

One roentgenogram; 4 photographs.

DON E. MATTHIESEN, M.D.
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## RADIOISOTOPES

**Isotope Implant Therapy for Internally Situated Tumors.** Paul V. Harper, Katherine A. Lathrop, Robert W. Harrison, Conrad G. Thurston, Thelma T. Kennedy, and John F. Mullan. Surgery **40:** 270–288, July 1956. (P. V. H., Department of Surgery, University of Chicago, Chicago 37, Ill.)

The authors describe a method for constructing isotope implants in internally situated tumors at operation, in which the applicator is subsequently charged with isotope in solution, thus avoiding exposure to the operator. The isotope solution may be removed or replaced as desired, and the choice of isotope is unlimited. Most of the authors' work has been confined to the use of $I^{131}$. Dosimetric calculation considerations are discussed, and experiments are presented.

The procedure was attempted in 9 cases of histologically verified carcinoma of the pancreas and was successfully completed in 7; in none of these cases was the tumor resectable. There was remarkably little reaction in terms of radiation sickness. Anemia secondary to the radiation was evident in patients receiving 100 mc or more of $I^{131}$. There was marked or complete

relief of pain in patients in whom this was a presenting symptom. Whether this was due to the effect of the radiation on the tumor or to the suppression of secretion in the acinar tissue of the pancreas blocked by the tumor is not clear. In 4 patients the portal vein traversed the implant, but this caused no apparent harm except in 1 case in which the implant became infected. On the basis of their experience with irradiation in advanced cancer of the pancreas with the implant technic, the authors believe that a high level of local radiation, of the order of 10,000 r, may well be beneficial in a number of cases and that continued exploration of the method is justified.

Polyethylene applicators, charged with $I^{131}$, were also used in 2 cases for local radiation therapy, one a case of multiple myeloma with involvement of the lumbosacral spine and protrusion of a large tumor forward into the pelvis and the other a squamous carcinoma of the ethmoid sinus with extension to the frontal lobe.

Ten figures, including 7 roentgenograms; 2 tables.

**A Sex Difference in the Response to Titrated Irradiation Therapy ($^{32}P$) of Patients with Chronic Granulocytic Leukaemia.** William H. Crosby, Oscar L. Sapp, and Hjalmar Anderson, Jr. Brit. J. Haematol. **2**: 317–320, July 1956. (Walter Reed Army Medical Center, Washington 12, D. C.)

Fourteen patients, 7 women and 7 men, with chronic granulocytic leukemia were under treatment for six months or more during the two years previous to the time of writing. Some had been treated elsewhere by other means, but at the Walter Reed Army Hospital they received, by the Osgood technic (Radiology **64**: 373, 1955), titrated total-body irradiation with $P^{32}$ injected intravenously. Starting with 40 μc per kg. of body weight, the dose was cautiously modified thereafter, depending upon the response of the patient. After a remission had been achieved, it was maintained by giving the patient, at well spaced intervals, enough $P^{32}$ to keep him in good condition, with a leukocyte count of about 20,000 per c. mm. It was found that no woman required as much irradiation as any of the men for control of the leukemia. The average dose of $P^{32}$ for the 7 women was 20 μc per kg. per month; the average for the 7 men was 83 μc. From the results of a statistical "run test," with the assumption that the only difference between the groups is sex, the difference in dose is considered to be statistically significant. There is less than one possibility in twenty that this difference was due to chance selection of patients over which the authors had no control.

One table.

**Lymphatic Dissemination of Radiogold in the Presence of Lymph Node Metastases.** Colin G. Thomas, Jr. Surg., Gynec. & Obst. **103**: 51–56, July 1956. (School of Medicine, University of North Carolina, Chapel Hill, N. C.)

The treatment of lymphatic metastases by radioactive colloids has been suggested because these colloids, when introduced interstitially, are disseminated by way of lymphatics until phagocytized primarily by reticuloendothelial cells in nodes along afferent pathways. The eradication of cancerous lymph nodes would depend upon their ability to phagocytize sufficient radiocolloid to result in their own destruction by radiation injury.

Experiments undertaken by the author were designed to study the routes of dissemination of radiocolloid in the presence of lymphatic metastases and its deposition in involved nodes. Tracer amounts of radiogold were injected preoperatively in or about primary cancers of the breast, head, or neck. Surgical removal of the primary neoplasm and its regional lymph areas was usually done within twenty to twenty-four hours and the specimen was examined with a Geiger-Müller counter and histologically. Thirty-five patients were studied, and 593 lymph nodes were removed. The criterion for the deposition of radiogold in a node was arbitrarily designated as a count per minute of twice the background.

Of the 593 lymph nodes studied, 94 contained cancer. In only 33 of these was radiogold deposited. Of 499 nodes free from cancer, 340 showed radiogold. The pathways of lymphatic flow and the filtering action of the nodes as evidenced by the presence of radiogold were not predictable. Although only tracer amounts of gold were used, it is doubtful that the distribution pattern with therapeutic doses would be much altered.

Functioning lymph tissue appeared to be essential for the phagocytosis of radiogold. In metastatic nodes lymph tissue was either replaced by the neoplastic process or rendered non-functioning. Furthermore, lymph node metastases may so alter normal lymphatic flow that there is less deposition in uninvolved nodes. The successful use of this method for the treatment of metastatic cancer appears, therefore, to be unlikely. It may actually be hazardous because of the dissemination of radioactive material to unpredictable sites.

Three photomicrographs; 3 drawings; 2 tables.

MORTIMER R. CAMIEL, M.D.
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**Clearance of Radioactive Iodine from the Lower Extremities of Patients with Myocardial Infarction.** Franz K. Bauer, Frederick R. Mugler, Jr., Vernon W. Lieberman, and John P. Westergart. Am. J. M. Sc. **232**: 44–49, July 1956. (Wadsworth General Hospital, VA Center, Los Angeles, Calif.)

Thirty-five patients with acute myocardial infarction were studied because earlier observations had indicated that the clearance of various radioactive isotopes from muscles occurred more slowly in persons with a history of previous myocardial infarction than in normal subjects (Am. J. M. Sc. **225**: 374, 1953. Abst. in Radiology **62**: 313, 1954.)

Tracer amounts of carrier-free $I^{131}$ in normal saline were introduced into the thigh by a jet injector. A scintillation tube was lowered over the injection site, and the disappearance of the injected radioactive tracer was recorded on a counting rate meter, either until half of the radioactivity had gone or for a period of from thirty to sixty minutes if disappearance was slow. Records were made also of 28 healthy control subjects.

In the healthy subjects, disappearance of half of the injected tracer occurred in from six to fourteen minutes. In the patients who had had myocardial infarction the range was from nine to sixty-seven minutes with the patient in the supine position, but the interval was greatly prolonged with the patient seated. In the course of convalescence, the clearance time approached normal.

The authors believe it possible that diminished cardiac output after myocardial infarction is followed by a compensatory reduction of the peripheral capillaries or arteriovenous anastomoses. The greatly prolonged

clearance in a sitting position, over the supine position, suggests a disturbance in homeostasis.

Three graphs; 1 drawing; 1 table.

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**Plasma, Tissue and Urinary Radioactivity after Oral Administration of $^{56}$Co-Labelled Vitamin $B_{12}$.** C. C. Booth and D. L. Mollin. Brit. J. Haematol. **2:** 223–236, July 1956. (Postgraduate Medical School of London, Ducane Road, London, W. 12, England)

The changes in the plasma, urinary, and tissue radioactivity of control subjects and patients with Addison's pernicious anemia were measured after the oral administration of 1 $\mu$g. of vitamin $B_{12}$ of relatively high specific activity labeled with $Co^{56}$ (half-life seventy-two days).

Radioactivity was demonstrable in the plasma of control subjects but not in the plasma of patients with pernicious anemia unless the labeled $B_{12}$ was given with an intrinsic factor. Plasma radioactivity did not increase until three to six hours after the dose, peak concentrations being reached at eight to twelve hours. The maximum amount of radioactivity in the plasma was equivalent to 3 to 12 $\mu\mu$g. per ml. of $Co^{56}$-$B_{12}$.

Radioactive material appeared in the urine of control subjects and patients with pernicious anemia given an oral dose of labeled $B_{12}$. Though the total amount excreted was very small, it appeared to be greater in the controls than in the patients. The excretion was maximal at eight to twelve hours.

Large parenteral injections of non-radioactive $B_{12}$, administered with or soon after the oral dose, did not materially alter the plasma radioactivity, although the amount of radioactivity in the urine was greatly increased. When parenteral injections of non-radioactive $B_{12}$ were given at the same time as the oral dose of $Co^{56}$-$B_{12}$, there was little or no increase of radioactivity in the urine during the first four hours. When the parenteral injections were given after radioactivity appeared in the plasma, excretion of radioactive material in the urine began immediately.

Hepatic radioactivity did not increase significantly for three to six hours after the oral dose; it then rose slowly to reach a peak two to six days later. The amount of radioactivity over the liver at the sixth to eighth day was directly proportional to the amount of $B_{12}$ absorbed.

Six figures; 6 tables.

**The Rate of Intravascular Equilibration of Intravenously Administered $I^{131}$-Labeled Albumin in Various Body Sites.** Arthur Bauman and Marcus A. Rothschild. J. Lab. & Clin. Med. **48:** 20–25, July 1956. (Radioisotope Service, VA Hospital, Bronx, N. Y.)

Following intravenous administration of $I^{131}$-labeled albumin or $P^{32}$- or $K^{42}$-labeled erythrocytes, ten to fifteen minutes are required for attainment of a relative plateau in concentration of radioactivity in arterial blood. Previous studies by the authors show, however, that after one or two circulations the apparent volume of distribution is already 80 per cent and, at one to one and a half minutes, 90 per cent of the final equilibrium level. This suggests that, while most of the circulation is in fairly rapid equilibration, some sites require up to ten minutes or more for complete intravascular mixing. The present investigation was aimed at evaluating the rates of intravascular equilibration in different parts of the body. The studies were carried out on male patients in a VA hospital.

The concentration of radioactivity over the head, chest, and liver was found to attain values higher than equilibrium levels within two minutes and then to decline to equilibrium levels. Intravascular radioactivity in forearm and calf increased gradually to reach equilibrium levels in one to four minutes and four to ten minutes, respectively. These findings are consistent with the interpretation that equilibration time in various tissues is determined principally by the ratio of blood flow to blood content.

Four figures.

**Effect of Radiophosphorus and Cortisone on Transplanted Mammary Adenocarcinomas in Susceptible and Resistant Mice.** Norman E. Boucher, Jr., Jerome T. Syverton, and John J. Bittner. Cancer Res. **16:** 22–31, January 1956. (University of Minnesota, Minneapolis 14, Minn.)

The authors present the results of studies of the influence of internal ionizing radiation from radioactive phosphorus ($P^{32}$), alone and in combination with cortisone, on the response of susceptible and resistant mice to the development of transplanted mouse mammary adenocarcinomas Z8352 and E0771.

Pretreatment with $P^{32}$ and cortisone in combination was found to enhance the development of implanted homologous Z8352 tumor tissue in susceptible ZBC and Zb mice. Neither $P^{32}$ or cortisone given alone elicited the enhancing effect obtained with these agents in combination.

Preparation of inbred C57BL/6 mice with $P^{32}$ and cortisone accelerated development of subsequently implanted E0771 homologous tumor transplants. Maximal tumor enhancement apparently depended upon an optimal relationship between the preparatory dose of the isotope administered in combination with cortisone and the concentration of tumor cells in the challenging inoculum.

Two charts; 7 tables.

**Transfer of Potassium Between Blood, Cerebrospinal Fluid and Brain Tissue.** Guilford G. Rudolph and Norman S. Olsen. Am. J. Physiol. **186:** 157–160, July 1956. (Radioisotope and Research Laboratories, VA Hospital, Nashville, Tenn.)

Five hundred microcuries of $K^{42}$, of high specific activity, was administered either intravenously or intrathecally to anesthetized dogs.

After intravenous injection the appearance of the ions in cerebrospinal fluid was a summation of two exponentials, with the maximum at about thirty minutes. The ratio of radioactivity of brain tissue to cerebrospinal fluid was stabilized at one hundred twenty minutes, whereas the ratio of cerebrospinal fluid to plasma reached this state after thirty minutes.

After intracisternal injection, the disappearance of $K^{42}$ from the cerebrospinal fluid was described by two exponentials. The activity in the plasma reached a maximum at ten to fifteen minutes and thereafter paralleled the disappearance curve from cerebrospinal fluid. Brain tissues did not reach equilibrium.

These data are compared with those obtained using radioactive sodium and bromide and are discussed in relation to cerebrospinal fluid formation.

One figure; 2 tables.

**Effect of Peritumoral Tissue Infiltration with Radioactive Yttrium on Growth and Spread of Malignant Cells.** Horace Goldie and Harold D. West, with the technical assistance of Louise F. Kelly, William B. Clark, and Deurward Hughes. Cancer Res. **16:** 484–489, July 1956. (Meharry Medical College, Nashville, Tenn.)

A standard dose (0.2 mc) of radioactive yttrium ($Y^{90}$) was injected in eight or ten fractions into peritumoral subcutaneous tissue of mice bearing sarcoma 180 or sarcoma 37 on the abdomen, leg or scalp. Twelve to forty-eight hours after tissue infiltration, autoradiographs were made and radioactivity was recorded by a Geiger counter. Tumor tissue showed a consistently higher level of radioactivity than adjacent muscle and the liver; radioactivity was low in the spleen and insignificant in other organs.

In a further experiment, requisite numbers (about $10^7$) of sarcoma cells were inoculated subcutaneously into the abdominal wall or into the scalp; one to five days later the tissue surrounding the site of inoculation was infiltrated (as above) with $Y^{90}$ (graded doses of 0.1 to 0.35 mc in various series). It was found that in the majority of mice treated with doses of 0.2 mc or higher two days after inoculation, tumor growth was scanty (nodules only) or absent, and survival was longer (often indefinite) than for untreated controls.

It is concluded that peritoneal treatment of large tumors affects (through necrosis) consistently only their periphery, but malignant cells scattered in normal tissue can be easily reached and inactivated by infiltrated $Y^{90}$ before the tumor becomes organized.

It is suggested that, in clinical therapy, infiltration of the tumor bed and tumor periphery with $Y^{90}$ may arrest peripheral growth and prevent the spread into normal tissue of scattered malignant cells from the tumor or of malignant cells "spilled" during surgery.

Four autoradiographs; 4 photographs; 2 tables.

**The Uptake of Radiosulfur in the Fractured Humerus in the Rat.** J. C. Osborne and K. Kowalewski. Surg., Gynec. & Obst. **103:** 38–40, July 1956. (University of Alberta, Edmonton, Alberta, Canada)

During the healing of long-bone fractures, cartilage is laid down at the site of injury and later ossifies by the process of endochondral bone formation. This cartilage has an affinity for injected radiosulfur ($S^{35}$), which suggests a means for investigation of the formation of callus.

In this study chemical measurements, uptake determinations, and radioautographic examinations were performed on 40 rats in which healing fractures were present in the humerus. It was shown that radiosulfur uptake in fractured bone is 2.2 times as great as in normal, intact bone. It was also apparent that more cartilage was formed when splinting was deficient and movement occurred at the injury site. Most of the uptake was found to be immediately adjacent to the fracture line.

The methods described should prove useful for further study of the healing of fractures and of cartilage and bone metabolism.

Two radioautographs; 2 tables.

DON E. MATTHIESEN, M.D.
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**Determination of Cell Volume in Massive Transfusions Using $Fe^{59}$ and $Cr^{51}$.** E. L. Smith, R. A. Huggins, L. Kraintz, R. A. Seibert, and S. Deavers. Am. J. Physiol. **186:** 97–100, July 1956. (Baylor University College of Medicine, Houston, Texas)

The authors found that when dogs are injected with either or both $Fe^{59}$- and $Cr^{51}$-labeled cells (initial tag) prior to a series of transfusions (up to 20.0–25.0 c.c. per cent body weight), the measured blood and cell volume closely approach and may exceed the expected figures. After completion of the series of transfusions, if an additional isotope (final tag) is injected, the blood and cell volumes are much less than expected. The difference between the blood and cell volumes determined by the initial and final tag can be explained by the "trapping" of red blood cells. The volume of red blood cells "trapped" after multiple transfusions (up to 10.0–14.9 per cent body weight) can equal or exceed the added cell volume.

**An Evaluation of the Fecal Recovery Method for Determining Intestinal Absorption of $Cobalt^{60}$-Labeled Vitamin $B_{12}$.** James A. Halsted, Peter M. Lewis, Elizabeth E. Hvolboll, Marvin Gasster, and Marian E. Swendseid. J. Lab. & Clin. Med. **48:** 92–101, July 1956. (J. A. H., VA Hospital, Syracuse 10, N. Y.)

The authors describe a method for carrying out the fecal elimination test for cobalt 60-labeled vitamin $B_{12}$ absorption which does not require transfer of the stool specimen from one container to another. Each specimen can be counted within half an hour. Results obtained in 42 patients in whom two or more tests were carried out under similar conditions indicate that the results are reproducible, usually within less than 10 per cent. As a research tool for quantitative measurement of intestinal absorption of vitamin $B_{12}$, the method is therefore reliable.

The average recovery of 0.5 mcg. $Co^{60}$-$B_{12}$ in 38 tests in 30 controls was 34 per cent, the highest figure being 57 per cent and the lowest 5 per cent. The lowest recovery in 34 tests in patients with intrinsic factor deficiency (Addison's pernicious anemia or total gastrectomy) was 78 per cent, with an average of 94 per cent. The test is thus reliable in the diagnosis of pernicious anemia. The greater simplicity of the urinary excretion test (Schilling), however, makes this preferable for that purpose.

The apparatus and technic described would provide a simple means of measuring fecal radioactivity of other gamma-emitting isotopes, such as $Fe^{59}$.

One photograph; 4 tables.

## RADIATION EFFECTS

**Fracture of the Femoral Neck Following Irradiation of the Pelvis.** Edgar L. Ralston. Surg., Gynec. & Obst. **103:** 62–66, July 1956. (University of Pennsylvania School of Medicine, Philadelphia 4, Penna.)

Nine cases of femoral neck fracture following pelvic irradiation for cancer were treated by the author between 1949 and 1954. The incidence of this complication has been reported as 1 to 2 per cent. Four case histories are included. The interval between irradiation and the appearance of hip symptoms in these cases ranged from nine months to about three years.

The tolerance dose for the femoral head and neck has

been estimated at 3,840 to 4,320 r but the exact effect of radiation is not clearly understood. There is no satisfactory explanation why one patient will experience a fracture and another will not; or why one hip will fracture and its opposite will not. Usually the amount of radiation is not enough to cause complete necrosis, but is sufficient to produce a subcapital zone of osteoporosis which so weakens this area that the stress of ordinary weight bearing may lead to fracture. In such an uncomplicated case, adequate callus and repair can be expected. When complete necrosis of the head occurs, it is assumed that the dosage has caused thinning of the bone trabeculae, endarteritis, and interference with the usual process of bone repair. Difficult healing or necrosis is probably related also to delayed diagnosis. In 3 cases which showed necrosis requiring prosthetic replacement, delay in diagnosis ranged from five to nine months.

It is obvious that optimum treatment results can be attained only if the complication is recognized early. This in turn means that it must be considered in all patients who complain of hip or knee pain following irradiation for pelvic cancer. Early films commonly fail to show the fracture, but films obtained after several weeks will reveal it.

Ten roentgenograms.

MORTIMER R. CAMIEL, M.D.
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**Radiation Injury to the Small Bowel with Special Consideration of Surgical Complications.** H. Harvey Peterson and Edwin G. Clausen. Gastroenterology **31:** 47–55, July 1956. (H. H. P., 401 Twentieth St., Oakland, Calif.)

Radiation injury to the small bowel occurs in 1 to 2 per cent of patients receiving radiation therapy for carcinoma of the pelvic organs and may develop many years after treatment. The occurrence is erratic; in addition to size of dose, individual susceptibility is important as a determining factor. The mucosa is very radiosensitive, and 2,500 r will kill or injure many cells. If the dose in the retroperitoneal lymphoid area reaches 5,500 r, bowel injury can be expected in 50 per cent of cases.

Pathologically the process consists essentially of mucosal ulceration in a sclerotic and relatively ischemic bowel, and lesions vary from superficial to very deep. Complications are bleeding, obstruction and perforation. The process usually reaches its maximum by the fourth week after therapy is terminated. Symptoms which persist longer suggest that permanent changes are taking place.

The diagnosis is dependent primarily upon suspicion. Diarrhea, malnutrition, bleeding of variable intensity, mucous stools, or symptoms of partial obstruction may be observed. Post-irradiation skin changes, a history of radiation therapy, or symptoms of radiation proctitis should suggest an irradiation effect.

Management is symptomatic and supportive. Intestinal antibiotics may be helpful. Surgical treatment is not contraindicated, and perforation, obstruction and hemorrhage are amenable to resection and end-to-end anastomosis.

Three case reports illustrate common complications of radiation enteritis.

One roentgenogram; 2 photomicrographs.

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Phoenix, Ariz.

**Carcinogenesis by Radioactive Substances.** Jacob Furth and John L. Tullis. Cancer Res. **16:** 5–21, January 1956. (Children's Cancer Research Foundation, 300 Longwood Ave., Boston 15, Mass.)

The authors review carcinogenesis in man by naturally occurring and artificially produced radioactive substances, the lung cancer problem in miners, the development of bone tumors in luminous dial painters and in patients treated with radium-containing nostrums, and the occurrence of cancers in patients who received Thorotrast ($ThO_2$) in diagnostic procedures several decades ago. They also review some of the experimental work which indicates the extensiveness, the limitations, the problems, and the prospects associated with the use of radioisotopes as carcinogenic agents. Brief consideration is also given to the external use of radioisotopes and to the "fall-out problem."

A bibliography of 90 references is appended.

Six figures; 3 graphs; 7 tables.

**Hepatic Duct Carcinoma Seventeen Years After Injection of Thorium Dioxide.** James C. Roberts, Jr., and Kenneth E. Carlson. Arch. Path. **62:** 1–7, July 1956. (University of Pittsburgh School of Medicine, Pittsburgh, Penna.)

A case of carcinoma of the hepatic duct is reported, developing seventeen years after intravascular injection of thorium dioxide into an extremity for demonstration of a peripheral vascular abnormality. Although no direct cause-and-effect relationship could be proved, traces of thorium dioxide were extremely prominent in portal lymph nodes and in the portal aspect of the liver. The presence of thorium dioxide was determined before death by means of abdominal roentgenography and proved after death by spectrochemistry. Radioactivity was demonstrated by gamma counting and autoradiographs. The estimate of the quantity of retained thorium dioxide, based on calculations of the amount found at autopsy in liver, lymph nodes, and spleen, was in remarkable agreement with the usual dosage for peripheral vasculography.

Ten illustrations; 1 table.

**Protection of Ovaries from Radiation.** Richard Batten and D. E. Meredith Brown. Lancet **1:** 939–940, June 16, 1956. (D. E. M. B., Birmingham Regional Hospital, Birmingham, England)

A method of protecting the ovaries during radiotherapy and its application in a single case are described. An eight-year-old girl was admitted to the hospital with a provisional diagnosis of pelvic neuroblastoma. Surgical removal of the tumor was scheduled, to be followed by radiotherapy. Since the heavy dose of irradiation required would probably sterilize the patient, it was planned to protect the ovaries at laparotomy by moving them out of the direct x-ray beam and ensheathing them in lead shells. On exploration, Aug. 12, 1952, it was found necessary to abandon attempts to enucleate the tumor, and a piece was excised for biopsy only. Since the ovaries were unexpectedly large, a pair of shields was fashioned, on the spot, from sheets of lead shaped manually and covered with rubber finger cots. The ensheathed ovaries were then sutured together and attached to the anterior parietal peritoneum as high as possible. The histologic diagnosis was neuroblastoma, with very little evidence of differentiation.

A course of x-ray therapy, for a total depth dose of 2,150 r, was given in thirty days, through anterior and

posterior fields measuring 14 × 12 cm., at 250 kv peak, 60 cm. focus-skin distance, h.v.l. 1.75 mm. Cu. At the end of treatment, the tumor could not be felt per rectum.

At a second laparotomy, Oct. 3, the right ovary, on release from its protective sheath, looked healthy and was returned to the pelvis. The left ovary, with its sheath, had escaped from the suture to the abdominal wall and had ulcerated into the wall of the pelvic colon, causing a pericolic abscess and fistula. The abscess was drained and a transverse colostomy performed. This was closed on Nov. 26.

At the time of writing, three years following treatment, the patient was in good health, with no clinical evidence of pelvic tumor. She started to menstruate at ten and a half years, with a regular cycle of twenty-eight days.

Three photographs; 1 drawing.

**The Surgical Management of Local Postradiation Effects.** J. J. Longacre. Am. J. Surg. **92:** 18–25, July 1956. (441 Vine St., Cincinnati 2, Ohio)

This article is illustrative of the repair necessary following the injudicious use of radiation as well as its appropriate use in cases where no other modality would have produced a cure so that a patient could live to the age where these radiation changes are now seen to take place. The author opens his article by saying that radiation therapy is a two-edged sword. It produces great benefit when properly administered for the treatment of malignant lesions, but is followed by a series of progressive and irreversible changes terminating in varying degrees of radiation sclerosis, at times in post-radiation necrosis, and occasionally in epitheliomatous neoplasia after eight to thirty-five years.

The biophysical factors concerned are discussed and the pathologic aspects are considered. Minor degrees of variation in tolerance are common, but actual idiosyncrasies appear to have decreased in proportion to improvement in knowledge and technic. The average time required for the development of cancer in post-irradiation tissue is said to be about twenty years.

Six before-and-after illustrations show the results of treatment. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

**Reconstruction of the Entire Anterior Abdominal Wall in the Presence of Postradiation Changes.** James E. Pridgen and Charles W. Tennison. Am. J. Surg. **92:** 54–56, July 1956. (414 Navarro St., San Antonio 5, Texas)

The authors report an example of the injudicious use of radiation, with repair ten years later of a very large defect in the abdominal wall. A tantalum mesh was utilized and a pedicle flap from the left iliac crest of the knee was used to replace the damaged soft tissues.

Six photographs. SYDNEY F. THOMAS, M. D.
Palo Alto, Calif.

**X-Rays in Dermatology.** Herbert Rattner (Chief Editor, Archives of Dermatology), W. Edward Chamberlain, *et al.* Arch Dermatol. **73:** 73–75, January; 266–271, March 1956.

While it is not our policy to abstract material appearing in the Correspondence columns of journals, attention is called to this discussion of the pros and cons of the use of x-rays in benign dermatologic conditions, because of the current interest in the problem of overexposure to radiation.

**X-Ray Exposure in Dermatology Personnel.** G. Thomas Jansen and Arthur C. Curtis. Arch. Dermat. **73:** 66–68, January 1956. (Department of Dermatology, University of Michigan Medical School, Ann Arbor, Mich.)

Since May 1951, members of the University of Michigan Department of Dermatology have worn lapel photographic film badge dosimeters as a part of an extensive monitoring program covering all University personnel who are in contact with radioactive materials and other sources of radiation. X-rays are the only form of radiation employed in the dermatology department; the x-ray machines are operated in the energy range of 94 to 100 kv. In the three and one-half year period covered by the present report, 462 film badges were used, each covering a two-week period of exposure. The technic of recording permitted minimal readings of 0.030 r per two-week period. In only one instance was overexposure detected, and this occurred in a nurse technician with a lax attitude toward exposure possibilities.

Two photographs; 2 tables.

**Roentgenoscopic Examinations as a Hazard to Patients.** Z. M. Bacq. J. belge de radiol. **39:** 685–695, 1956. (In French) (Faculté de médecine, Université de Liège, Liège, Belgium)

The majority of radiobiologists present at the 1955 Geneva conference for pacific utilization of atomic energy endorsed the belief that penetrating radiation constitutes a serious genetic hazard for future generations. In Belgium, cosmic radiation amounts to about 0.1 r yearly (5 to 6 r for the average life span). These figures are two to three times higher on the plateaus of the Andes or Himalayas, or when habitations are built of granite and other primitive rocks with high uranium content. Since the genetic influence of ionizing radiations is strictly cumulative, the absence of comparatively higher racial deterioration in the populations subjected to this additional radiation has been explained by their high fertility and mortality, facilitating the natural selection of unfavorable mutants. According to J. H. Muller, a dose of 80 r doubles the number of spontaneous mutations in mice; on the basis of this figure, 20 r is considered the maximum permissible total (life span) amount for persons from relatively primitive populations. The hygienic conditions and superior medical care in civilized countries is not conducive to natural selection. The author believes that the genetic hazard will lead to a limitation in the development of industrial and other uses of nuclear energy, unless and until satisfactory methods of protection can be found.

In recent publications the total permissible dose of 20 r for human beings has been reduced to 15 r. This concerns in no way the radiation therapy of malignant neoplasms, particularly in patients beyond the reproductive stage; yet, in certain countries, healthy young males are given up to 500 r over the testicles to produce temporary sterility, childbearing is allowed after ovarian irradiation, and roentgen pelvimetry is increasingly performed prior to delivery. Some experiments seem to indicate that even radiation applied outside the gonads may have an (indirect) genetic effect. A barium meal represents about 30 r of exposure, most

roentgenoscopic installations used by non-roentgenologists have never been calibrated (those that were had often an output in excess of 40 r/min.), and poorly constructed television sets leak ionizing radiation. Severe legislative action could restrict the use of penetrating radiation as, for instance, the roentgenoscopic shoe-fitting devices. This does not mean that roentgenography, or even roentgenoscopy, should be curtailed to the point of endangering the patient's welfare by delays in diagnosis or in the evaluation of treatment procedures. However, special roentgen methods (ten-second angiocardiography may cause an exposure of 50 r) should be reserved for definite indications.

In Belgium, much effort has been devoted since 1950 to the improvement of the so-called chemical protectors The author has perfected a compound called MEA (mercaptoethylamin) available commercially in Europe (under the trade name Bécaptan disulfure Labaz), the effectiveness of which is said to have been established experimentally by Maisin of Louvain, Wolff of Strassburg, and Rugh of New York.

E. R. N. GRIGG, M.D.
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**The Genetically Significant Radiation Dose from the Diagnostic Use of X-Rays in England and Wales. A Preliminary Survey.** S. B. Osborn and E. E. Smith Lancet **1**: 949–953, June 16, 1956. (S. B. O., University College Hospital, London, England)

The authors describe an attempt to estimate the genetically significant dose of radiation received by the population of England and Wales from diagnostic radiology. An analysis was made of the number of x-ray examinations performed per annum in the two countries, and a subdivision obtained from five selected hospitals as to the type of study and the age and sex of the patients. In addition, an assessment was made of the minimum dose received by the gonads in each type of examination and the probability of reproduction as a function of age.

The results show that it is unlikely that the genetically significant radiation dose received by the population of England and Wales from diagnostic x-ray examinations amounts to less than 22 per cent of that received from natural sources, and it may well be several times greater than this figure. Most of this radiation is received in a few types of examination, undergone by relatively few patients, and by fetal gonads during pregnancy.

Six tables.

**Retention of Radon Decay Products in Human Lungs.** Čestmír Jech. Arch. Indust. Health **13**: 475–479, May 1956.

A method has been developed for a continuous registration of radon decay products (or other radioactive aerosols) in exhaled air. By this method it has been established that, after inhalation of air containing decay products of radon, the concentration of these products in the expired air varies greatly during the course of an exhalation, dropping from a relatively high initial value to about 30 per cent of the inhaled concentration at the end of each normal exhalation and practically to zero during a deep exhalation. This is explained by the large retention efficiency of the deep (capillary) parts of the lungs.

Four figures.

**Impact of the Atomic Energy Industry on Community Health.** Panel Discussion at the Fifteenth Annual Congress on Industrial Health, sponsored by the Council on Industrial Health, American Medical Association, and the Medical Society of the District of Columbia and arranged by the Division of Biology and Medicine. U. S. Atomic Energy Commission, Washington, D. C., Jan. 25–26, 1955. Edited by Roy E. Albert. Arch. Indust. Health **13**: 425–467, May 1956.

This discussion of impact of the atomic energy industry on community health comprises 13 papers by individual authors on various phases of the subject. It includes, among others, articles on the hazards in the operation of a nuclear reactor, on health problems associated with the use of radioisotopes in industry and in medicine, and on health problems in the radiochemical processing industry.

**A Method of Measuring the Tissue-Damaging Action of X-Rays.** H.-J. Heite and K. H. Nicolai. Strahlentherapie **100**: 455–462, July 1956. (In German) (Hautklinik der Philipps-Universität Marburg/Lahn, Marburg/Lahn, Germany)

For measuring the effect of x-rays on the tissues, the authors punched a round hole, 6 to 7 mm. in diameter, in each ear of a series of rabbits. One ear was irradiated, while the other served as a control. The action of the x-rays was judged by the time required for healing, as indicated by the reduction of the diameter of the punch hole. For the measurements, a polished probe-like graduated metal cone was introduced into the hole every few days, for thirty-five to fifty days.

When $u$ is the diameter of the test hole and $v$ is the diameter of the control hole, $x = u - v$, the difference between the two holes. When $n$ is the number of animals tested and $S_x$ is the scattering of the values for $x$, $t = (x/Sx)\sqrt{n}$.

Tables for $t$ functions are available (Weber, E.: Grundriss der biologischen Statistik, Jena, 1956; Linder, A: Statistische Methoden, Basel, 1945) which make it possible to read off immediately the probability that $x$ is due to chance or is significant.

The method has been applied in particular to the measuring of the difference between the reaction under a compression cone and an open cone and has confirmed objectively and statistically the concept that compression reduces the reaction to x-rays.

The authors also investigated in this manner the influence of fractionation, with decrease and increase in the size of the dose. The following fractionations were compared:

| Decrement | Increment |
|---|---|
| 6 × 500 r | 10 × 300 r |
| 3 × 400 r | 5 × 400 r |
| 11 × 300 r | 5 × 500 r |
| Total 7,500 r | Total 7,500 r |

The reaction was less with fractions of increasing size.

The punch-hole test is recommended by the authors for a variety of radiobiological investigative problems.

Nine illustrations; 3 tables.

GERHART S. SCHWARZ, M.D.
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**The Dependence of the Latency Period of Radiobiologic Reaction on the Size of the Dose.** Felix Wachsmann and Apostolos Yiannakopoulos. Strahlen-

therapie **100**: 428–432, July 1956. (In German) (Medizinischen Universitätsklinik Erlangen, Erlangen, Germany)

Rajewsky and collaborators [reference not given] are said to have shown that the survival time of white mice after total-body exposure varies with the dose as follows: 1,000–10,000 r, three and a half days; 40,000 r, one day; 100,000 r, one hour; 200,000 r, one minute.

For their own experiments the authors used: (1) a Siemens Stabilivolt, 180 kv, with a maximum dosage rate of 860 r/min. (at 20 cm. F.S.D.); (2) a Siemens Dermopan with beryllium window tube, with a maximum dosage rate of 750,000 r/min. (at 20 mm. F.S.D.); (3) a 6-MEV Siemens Reiniger Betatron with a dosage rate of 5,000 r/min. of fast electrons (5 MEV).

The growth of roots of sprouting peas exposed to these various types of radiation was recorded daily. The doses delivered to the peas at the onset of observations varied from 100 r to 25,600 r. The higher the dose, the greater was growth retardation. An interesting secondary finding was a growth stimulation with 100 r and 200 r. [No statement is published about temperature control, though the rate of growth of pea sprouts is very dependent on temperature.—G. S. S.]

Skin erythema, epitheliolysis, and necrosis were observed in irradiated rats. Graphs indicate that the reactions following the three forms of radiation were of a different pattern as far as latency is concerned. Common to all, however, was a decrease of the latency period with an increase in dose from 3,000 r to 100,000 r.

A hitherto unreported radiobiologic reaction was observed on rat tails. After doses of 1,500 to 15,000 kiloroentgens, the tail exhibits a pale yellow discoloration and glass-like appearance. It becomes brittle and breaks off easily, with only slight bleeding. This reaction is immediate.

Four illustrations. GERHART S. SCHWARZ, M.D.
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**Investigation into Experimental Production of Cancer by Local Beta Irradiation.** G. Schubert, H. A. Künkel, L. Overbeck, and G. Uhlmann. Strahlentherapie **100**: 335–351, July 1956. (In German) (Universitäts-Frauenklinik Hamburg-Eppendorf, Hamburg-Eppendorf, Germany)

There are conflicting opinions on the relationship between the incidence of experimental tumor production and the latent period. Whereas it is held that a high tumor rate is associated with a short period of latency, it is also being maintained that low-intensity, long-protracted radiations produce the highest number of tumors.

In order to resolve this question in part, the authors implanted strontium-90 glass beads of 1.5, 30, 45 and 85 microcuries strength (pure beta emitters) permanently in rats. In 80 animals with subcutaneous implants the rate of palpable tumor formation was found to be proportional to the logarithm of the intensity of the beads. The shortest latency period was 270 days, the longest 400. The total number of tumors produced was 31. Of secondary interest was the fact that with the lowest intensity (1.5 $\mu$c), the tumor formation rate was still 36 per cent despite the fact that the source was so weak that it was incapable of producing epilation.

The intensity of the source was in inverse proportion to the latency period. The weakest source produced the longest latency period. The values, when plotted on arithmetic graph paper, lie on a straight line. The time at which epilation occurred was found to be 1,350 $\mu$c $\times$ days. These values lie on a hyperbolic curve.

In 134 rats a single bead was implanted intraperitoneally, producing tumors in 38.

The localization and histology of the tumors are discussed in detail.

Thirty-three illustrations.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

**Indirect Induction of Lymphomas in Irradiated Mice. I. Tumor Incidence and Morphology in Mice Bearing Nonirradiated Thymic Grafts.** Henry S. Kaplan, William H. Carnes, Mary B. Brown, and Barbara B. Hirsch. Cancer Res. **16**: 422–425, June 1956. (Departments of Radiology and Pathology, Stanford University School of Medicine, San Francisco, Calif.)

Lymphomas were found to develop with moderate and reproducible frequency in thymectomized, irradiated (4 doses of 168 r each at eight-day intervals) C57BL mice bearing grafts of normal isologous thymus glands. These tumors resembled in latent period, morphological appearance, and organ distribution the lymphomas arising in the thymuses of intact irradiated mice of this strain. In every instance of lymphoma in the present experiment, the graft was involved and, in more than half the instances, involvement was limited to the graft and immediately surrounding tissues. In a few instances the tumor was confined to the graft without invasion of surrounding structures. These observations compel the conclusion that, under the conditions of the experiment, the lymphomas originate in the grafts.

Four photomicrographs; 3 tables.

**Indirect Induction of Lymphomas in Irradiated Mice. II. Factor of Irradiation of the Host.** Henry S. Kaplan, Mary B. Brown, Barbara B. Hirsch, and William H. Carnes. Cancer Res. **16**: 426–428, June 1956. (Departments of Radiology and Pathology, Stanford University School of Medicine, San Francisco, Calif.)

The effect of irradiation of thymectomized mice on the incidence of lymphoid tumors in subsequently implanted isologous thymic grafts was studied (see preceding abstract). In a series of experiments, it was found that: (1) systemic irradiation of the host is essential for the induction of these tumors in more than sporadic numbers; (2) the lymphomogenic effect of irradiation persists for as long as eight days after the last of a series of fractional exposures; (3) the effect is strikingly inhibited or abolished by shielding one thigh during irradiation or by the intravenous injection of isologous bone marrow cells after irradiation.

The effects of irradiation, thigh-shielding, and marrow injection on the incidence of implant lymphomas closely resemble those previously observed for thymic lymphomas arising *in situ* in intact mice of this strain (see, for example, Kaplan *et al:* Cancer Res. **12**: 441, 1952. Abst. in Radiology **60**: 482, 1953).

**Indirect Induction of Lymphomas in Irradiated Mice. III. Role of the Thymic Graft.** William H. Carnes, Henry S. Kaplan, Mary B. Brown, and Barbara B. Hirsch. Cancer Res. **16**: 429–433, June 1956. (Departments of Pathology and Radiology, Stanford University School of Medicine, San Francisco, Calif.)

The experiments described in the present paper were

designed to reveal the role of implanted tissue (see preceding abstracts) in the mechanism of lymphoma induction. The regeneration of cortical tissue in isologous thymic grafts in thymectomized C57BL mice was followed by semiserial histologic sections at frequent intervals after implantation. Cortical regeneration was nearly complete by the fourteenth day in non-irradiated hosts and reached its maximum in irradiated hosts at about the same time. The incidence of cortical regeneration in the grafts in irradiated hosts is sufficient to account for the observed incidence of lymphomas at later intervals.

Prior systemic irradiation of the recipients was found to impair the incidence and extent of cortical regeneration in the grafts. Thigh-shielding during such irradiation permitted the grafts to regenerate as completely as in non-irradiated hosts.

The age of the thymus donor had an important effect on the incidence of tumors in the grafts, the peak susceptibility occurring in the implants from the youngest donors. Prior to puberty the sex of the donor had no influence on the susceptibility of the implant to lymphoma development.

Eighteen photomicrographs; 3 tables.

**Indirect Induction of Lymphomas in Irradiated Mice. IV. Genetic Evidence of the Origin of the Tumor Cells from the Thymic Grafts.** Henry S. Kaplan, Barbara B. Hirsch, and Mary B. Brown. Cancer Res. **16**: 434–436, June 1956. (Department of Radiology, Stanford University School of Medicine, San Francisco, Calif.)

This paper is concerned with a two-stage experiment, the main purpose of which was to answer the question: Do thymic implant tumors behave on genetic test as if they arose from the cells of the implant or from those of the host? As a by-product, the first stage of the experiment also answered the question: Is genetic susceptibility or resistance of various mouse strains to thymic lymphoid tumor development transmitted as an intrinsic property of their thymic tissue?

Strain C57BL mice, highly susceptible to radiation-induced lymphomas, and C3H(b) mice, which are relatively refractory, were reciprocally mated. The $F_1$ hybrids were thymectomized, irradiated (with x-rays, dosage not given), and then implanted with thymic grafts from non-irradiated mice of the two parental strains and other $F_1$ hybrids. Lymphomas developed in 26 per cent of the C57BL grafts, 33 per cent of the $F_1$ hybrid grafts, and only 3 per cent of the C34(b) grafts after fifteen months. It is concluded that genetic control of susceptibility is transmitted as an intrinsic property of the thymic target tissue. No significant difference in response of grafts from reciprocally derived $F_1$ hybrids was observed.

The lymphoid tumors thus induced were then tested for their ability to "take" and grow progressively in intact young C57BL, C3H(b), and $F_1$ hybrid mice. C57BL implant tumors grew in both C57BL and hybrid test mice, but not in C3H(b) animals; hybrid implant tumors grew only in other hybrids. It is concluded that the tumor cells in these implant lymphomas are derived from the cells of the thymic graft and not from the cells of the host. Since the thymic grafts had not been irradiated and irradiation of the host mice was completed prior to implantation, this result conclusively establishes the fact that these tumors were induced by a completely indirect mechanism.

Two tables.

**Comparative Activity of Isologous Vs. Homologous or Heterologous Mouse Bone Marrow in Promoting Regeneration of the Irradiated Mouse Thymus.** Barbara B. Hirsch, Mary B. Brown, C. Susan Nagareda, and Henry S. Kaplan. Radiation Res. **5**: 52–57, July 1956. (Department of Radiology, Stanford University School of Medicine, San Francisco, Calif.)

These experiments demonstrate that strain C3H, Bagg A, and C3H × C57B1 $F_1$ hybrid mice all exhibit a phenomenon previously noted in C57B1 mice, namely that either the shielding of one thigh during periodic whole-body irradiation or the intravenous injection of isologous bone marrow immediately after the last irradiation promotes early recovery of thymic weight.

The factor in bone marrow responsible for thymic weight regeneration is highly strain-specific: isologous marrow was consistently effective, whereas homologous and heterologous marrow gave no evidence of activity. This was best demonstrated by the cross-responses of $F_1$ hybrids and their parent strains to hybrid versus parental marrow. The disparity between these results and those of other investigators, in which heterologous marrow afforded partial protection against radiation mortality, is discussed.

One table. AUTHORS' ABSTRACT

**Conditioned Responses to Manipulative Procedures Resulting from Exposure to Gamma Radiation.** John Garcia, Donald J. Kimeldorf, and E. L. Hunt. Radiation Res. **5**: 79–87, July 1956. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

A depression in consumption of food and water during exposure to low-level gamma radiation has been reported previously (Radiation Res. **4**: 33, 1956. Abst. in Radiology **67**: 803, 1956). The studies recorded here are designed to determine if conditions associated with previous exposures can produce a similar effect in the absence of radiation exposure. Groups of rats were exposed to one, three, and five periods of low-level (9.4 r/hr) gamma irradiation for eight hours per exposure. These animals were then subjected to a sham-exposure test, *i.e.*, manipulation and confinement to plastic irradiation chambers, without exposure, for a similar period. Food and water consumption was decreased in the groups which previously had suffered multiple exposures, an effect which is similar to that seen during the actual radiation exposures. In contrast, littermate controls subjected only to sham irradiations maintained or increased consumption with repeated confinement. Animals which were deprived of food and water during five exposure periods did not show a decrement in consumption during the sham-exposure test. When rats were given access to food but not water during exposure, consumption of both decreased during the sham-exposure test. It was concluded that manipulation and confinement associated with radiation exposure acted as conditioned stimuli to produce the reduction in consumption and that the ingestion of water and/or food during radiation exposure was necessary to produce the effect.

Four figures; 1 table. AUTHORS' ABSTRACT

**Responses to Whole-Body X-Irradiation in the Starved Rat.** L. F. Nims and J. L. Geisselsoder. Radiation Res. **5**: 58–64, July 1956. (L. F. N., Department of Biology, Brookhaven National Laboratory, Upton, L. I., N. Y.)

Some of the changes in the ability of the rat to re-

spond to whole body x-irradiation, under starvation conditions, have been studied. The absolute fall in adrenal cholesterol or ascorbic acid levels indicative of stimulation of the pituitary-adrenal system by the irradiation is but little affected by starvation. The first day increase in water consumption and the increase of liver glycogen following irradiation become less as starvation proceeds, indicating a loss of sensitivity of peripheral mechanisms to altered hormonal levels as body stores become depleted. The hypertrophy observed in the adrenal gland due to starvation did not appear to be affected by x-irradiation.

Four graphs; 1 table. AUTHORS' ABSTRACT

**Animal Experiments on Radiosensitivity of Growing Bone.** Pierre van Caneghem and Carl Georg Schirren. Strahlentherapie **100:** 433–444, July 1956. (In German) (Universität München, Munich, Germany)

The right legs of 150 white leghorn chickens were irradiated with varying doses of x-rays in the 10 to 50-kv range. Two principal reactions recorded were: (1) retardation of bone growth, expressed by the difference in length between the exposed and unexposed leg; (2) soft-tissue damage resulting in fibrosis and ankylosis of joints.

Reaction 1 increased with the hardness of radiation, reaction 2 with its softness. Growth retardation was more severe when the irradiated chicken was young, being twice as great when the dose was delivered on the fourth day of life as when it was delivered on the fourteenth day. A single dose of 800 r with back-scatter was not followed by any definite change; 1,200 r with back-scatter produced growth retardation with great regularity; 2,000 r with back-scatter caused severe soft-tissue damage in addition to increased growth retardation. With fractionation into 8 × 250 r (within eight days) neither reaction occurred. The chickens were examined up to the 105th day of life.

Nine illustrations; 6 tables.

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**Urinary Excretion and Plasma Levels of Free Ninhydrin Reactive Compounds in X-Irradiated Rats.** R. E. Kay, D. C. Harris, and C. Entenman. Am. J. Physiol. **186:** 175–179, July 1956. (Biological and Medical Sciences Division, U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Urinary excretion and plasma levels of ninhydrin-reactive compounds in irradiated rats were studied quantitatively. In the investigation of urinary excretion, fasted rats were exposed to either a sublethal (450 r) or supralethal (2,500 r) whole-body dose of 250-kvp x-rays. Twenty-four-hour urines, taken from two days pre-irradiation to three days postirradiation, were analyzed for ninhydrin-reactive compounds. During the day following irradiation, rats exposed to either sublethal or supralethal doses excreted increased amounts of urinary taurine, cysteic acid, leucine, and valine.

In the plasma studies four groups of rats were exposed to 600 r of whole-body x-irradiation. At six, twelve, twenty-four, and thirty hours after irradiation, plasma was analyzed for ninhydrin-reactive compounds and creatinine. Transitory elevations in plasma concentrations of lysine, glutamine, taurine, methionine, valine and leucine occurred, while elevations in the levels of arginine, serine plus glycine, threonine, alanine, and creatinine were not observed.

The increased urinary excretion of non-glycogenic amino acids may be the result of a breakdown of protein or protein-like compounds to amino acids, with subsequent rapid conversion of the excess glycogenic amino acids to liver glycogen. The early excessive excretion of taurine in the irradiated rat suggests an increased oxidation of sulfur-containing compounds.

Two tables.

**The Elimination of Radioactive Barium Sulfate Particles from the Lung.** H. Cember, T. F. Hatch, J. A. Watson, T. Grucci, and P. Bell. Arch. Indust. Health **13:** 170–176, February 1956. (Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Penna.)

The radiation effect on the pulmonary clearance mechanisms was studied by exposing one group of rats to radioactive barium sulfate particles of high specific activity and another group to particles of very low specific activity. No difference between the elimination rates of these two classes of particles was observed. The effective half-life of the particles in the deep respiratory tract was found to be two days. Although there was a suggestion that the particles may undergo solution in the lungs, the chief route of elimination was mechanical removal up the bronchial tree, followed by swallowing and subsequent elimination *via* the urine and feces.

Five figures; 4 tables.

**Similarities in Killing by Heat and by X-radiation in the Insect Dahlbominus fuscipennis (Zett.).** William F. Baldwin. Radiation Res. **5:** 46–51, July 1956. (Atomic Energy of Canada Limited, Chalk River, Ontario)

Several marked similarities were found between killing by x-rays and heat killing in starved adults of the small chalcid *Dahlbominus*. At temperatures of 40 to 45° C. the insects soon become immobile and comatose; recovery from this coma is complete when the heat exposure is not prolonged. The immediate results of exposure to x-ray doses of 200,000 roentgens is a similar coma, and recovery is again complete. Death from delayed effects of both heat and x-rays occurred later. Tolerance of female insects to both heat and x-rays diminished with increasing age; diploid females were more resistant to both agents than haploid males; moderately high temperatures (32° C.) increased tolerance to heat and x-ray exposures; the responses to varying doses of heat and x-rays covering wide ranges of mortalities did not yield linear dose-effect relationships, since sharp breaks were found at comparatively low dose levels of each agent. These parallels in response to heating and to x-irradiation indicate that at least a part of the mechanism of killing may be the same in the two cases. As the similarities are qualitative rather than quantitative, especially in regard to sex and preconditioning effects, presumably only a part of the mortality mechanism is similar. These similarities may be peculiar to organisms (such as insects) in which cell divisions are absent, or nearly so, and in which massive doses of x-radiation are required to kill.

Two graphs; 3 tables. AUTHOR'S ABSTRACT